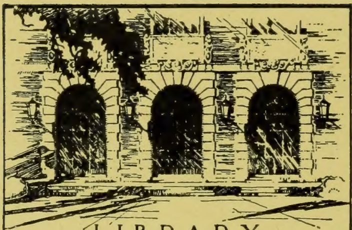

Volume Ten Number Two

SCHOOL OF MINES

AND

METALLURGY

UNIVERSITY OF MISSOURI

BULLETIN

MARCH, 1918

1917—CATALOGUE—1918

ROLLA, MISSOURI

Entered as second-class matter January 7, 1909, at the postoffice at Rolla, Missouri, under the act of July 18, 1894. Issued Quarterly.

SCHOOL OF MINES

AND

METALLURGY

UNIVERSITY OF MISSOURI

FORTY-SEVENTH ANNUAL CATALOGUE

ROLLA, MISSOURI

1918

SOUTH GATE

CALENDAR 1918-1919

1918

JANUARY

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ROLLA BUILDING

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CALENDAR

1918

August 30 and 31, Friday and Saturday	Registration.
September 2, Monday	Class Work Begins.
November 28, Thursday (just one day)	Thanksgiving Holiday.
December 21, Saturday, 12 Noon	Fall Term Closes.

1919

January 3 and 4, Friday and Saturday	Registration for Winter Term.
January 6, Monday	Class Work Begins.
February 22, Saturday	Washington's Birthday, Holiday.
April 26, Saturday	Commencement Day.
April 28, Monday	Registration for Spring and Summer Term.
July 4, Friday	Independence Day, Holiday.
August 16, Saturday	Spring and Summer Term Closes.

BOARD OF CURATORS

S. L. Baysinger	*Rolla, Mo.*
John H. Bradley	*Kennett, Mo.*
D. R. Francis	*St. Louis, Mo.*
H. B. McDaniel	*Springfield, Mo.*
G. E. Muns	*Montgomery City, Mo.*
Albert D. Nortoni	*St. Louis, Mo.*
C. B. Rollins	*Columbia, Mo.*
Sam Sparrow	*Kansas City, Mo.*
Milton Tootle, Jr	*St. Joseph. Mo.*

OFFICERS OF THE BOARD

D. R. Francis	*President.*
C. B. Rollins	*Vice-President.*
J. G. Babb	*Secretary.*
R. B. Price	*Treasurer.*

EXECUTIVE COMMITTEE

S. L. Baysinger .... *Rolla.*
Albert D. Nortoni .... *St. Louis.*
H. B. McDaniel .... *Springfield.*

OFFICERS OF THE COMMITTEE

S. L. Baysinger .... *Chairman.*
Edw. Kahlbaum .... *Secretary.*
C. M. Knapp .... *Treasurer.*

FACULTY

ALBERT ROSS HILL,
President of the University.
A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905; Dalhousie University, 1908; Westminster College, 1909; Washington University, 1915; Lafayette College, 1915; Universities of Colorado and Michigan, 1916; University of California, 1918.

AUSTIN LEE McRAE,
Director and Professor of Physics.
B. S., University of Georgia, 1881; S. D., Harvard University, 1886.

JOSEPH WAYNE BARLEY,
Professor of English and Modern Languages.
A. B., 1897; A. M., 1905; William Jewell College; Ph. D., University of Pennsylvania, 1911.

GUY HENRY COX,
Professor of Geology and Mineralogy.
B. S. in General Science, Northwestern University, 1905; M. A., 1908; Ph. D., University of Wisconsin, 1911; E. M., School of Mines, 1914.

GEORGE REINALD DEAN,
Professor of Mathematics and Secretary of the Faculty.
C. E., School of Mines, 1890; B. S. in Mathematics and Physics, School of Mines, 1891.

HAROLD SHIELDS DICKERSON,
Professor of Mechanical Engineering.
B. S., University of Michigan, 1905; B. S., Purdue University; M. E., Purdue University, 1911.

CARROLL RALPH FORBES,
Professor of Mining.
B. S., Michigan College of Mines, 1902; E. M., Michigan College of Mines, 1903. On leave, Capt. and Adj., 3rd Battalion, 113th Engineers.

VICTOR HUGO GOTTSCHALK,
Professor of Chemistry.
B. S. in Chemistry and Metallurgy, School of Mines, 1898; M. S., School of Mines, 1900; Ph. D., University of Chicago, 1917.

ELMO GOLIGHTLY HARRIS,
Professor of Civil Engineering.
C. E., University of Virginia, 1882.

CHARLES E. LOCKE,
Special Lecturer in Mining.
Massachusetts Institute of Technology.

HAROLD LESLIE WHEELER,
Librarian.
A. B., Brown University, 1910; B. L. S., New York State Library School, 1913.

THOMAS THURMON McCONNELL,
Director of Athletics.
B. S. in Agriculture, Purdue University, 1914.

FRANK EDWARD DENNIE,
Associate Professor of Athletics and Physical Director.
B. S. in Civil Engineering, Brown University, 1909. On leave, Capt. Co. C, 314th Engineers.

LEON ELLIS GARRETT,
Associate Professor of Mathematics.
B. S. in General Science, School of Mines, 1901.

HORACE THARP MANN,
Associate Professor of Metallurgy and Ore Dressing, in charge of Metallurgy Department.
B. S. in Mining Engineering, School of Mines, 1908; M. S. in General Science, School of Mines, 1909; E. M., School of Mines, 1910.

OSWALD HANCE BLACKWOOD,
Assistant Professor of Physics.
A. B., Boston University, 1909.

JOSEPH HENRY BOWEN,
Assistant Professor of Shop Work and Drawing.
Graduate, Miller School, Virginia.

CHARLES YANCEY CLAYTON,
Assistant Professor of Ore Dressing and Metallurgy.
B. S. in Metallurgy, School of Mines, 1913; Met. E., School of Mines, 1916.

CHARLES LAURENCE DAKE,
Assistant Professor of Geology and Mineralogy.
A. B., 1911; A. M., 1912; University of Wisconsin. On leave, 1917-1918.

FRANCIS POTTER DANIELS,
Assistant Professor of Modern Languages.
A. B., University of Michigan, 1895; A. M., University of Missouri, 1897; Ph. D., University of Missouri, 1905.

RALPH EARL DUFFY,
Assistant Professor of Drawing.
B. S. in E. E., University of Missouri, 1908. On leave, 1917-1918.

HOWARD LEROY DUNLAP,
Assistant Professor of Chemistry.
B. S., Ohio University, 1912; M. A., Ohio State University, 1914.

EDGAR SCOTT McCANDLISS,
Assistant Professor of Civil Engineering.
B. S. in Civil Engineering, Purdue University, 1909; C. E., School of Mines, 1917. On leave, Capt. and Adj., 1st Battalion, 314th Engineers.

GARRETT A. MUILENBURG,
Assistant Professor of Geology and Mineralogy.
A. B., 1912, M. S., 1913, University of Iowa.

WILLIAM DeGARMO TURNER,
Assistant Professor of Chemistry.
B. S., 1909, Ph. D., 1917, University of Chicago.

ROLLAND SCHANEL WALLIS,
Assistant Professor of Civil Engineering.
B. S. in E. E., 1907; B. S. in C. E., 1909; C. E., 1915, Iowa State College.

HENRY HORTON ARMSBY,
Instructor in Civil Engineering.
B. S., 1911, C. E., 1916, Pennsylvania State College.

JOSEPH BRYANT COLE,
Instructor in Machine Shop.

FLOYD HILL FRAME,
Instructor in Physics and Electricity.
A. B. Clark College, 1912. On leave, First Lieut. Ordnance Dept. U. S. A.

VAN BUREN HINSCH,
Instructor in Mathematics.
B. S., 1909, E. M., 1917, School of Mines.

NEIL CHARLES HUTSINPILLAR,
Instructor in English.
B. A., Ohio State University, 1908.

R. STEWART LILLARD,
Instructor in Civil Engineering.
B. S. in C. E., University of Tennessee, 1916. On leave, 1st Lieut. A. E. F.

MARTIN HARMON THORNBERRY,
Research Assistant.
B. S., School of Mines, 1912.

STUDENT ASSISTANTS

EVAN EARL ASHLOCK,
Student Assistant in Drawing.

ROBERT BRUCE,
Student Assistant in Physical Training.

*EDGAR CARL BURKHART,
Student Assistant in Civil Engineering.

*RAUL CHAVEZ,
Student Assistant in Modern Languages.

HOWELL SMITH CLARK,
Student Assistant in Geology and Mineralogy.

†LEWIS ELY DAVIDSON,
Student Assistant in Mechanical Engineering.

RAYMOND JOHN DOWD,
Student Assistant in Physical Training.

*MILBURN LEO DORRIS,
Student Assistant in Physical Training.

*JEROME EMERSON FLANDERS,
Student Assistant in Mining.

JAMES PRESSLEY GILL,
Student Assistant in Metallurgy and Ore Dressing.

*IRVIN BENSON JOHNSTON,
Student Assistant in Physical Training.

FREDERICK ARTHUR KRAUSE,
Student Assistant in Chemistry.

ORIE NEWELL MANESS,
Student Assistant in Mining and in Metallurgy and Ore Dressing.

†RICHARD WESLEY MELLOW,
Student Assistant in Mechanical Engineering.

---

*First Semester
†Second Semester

BENJAMIN GUTHRIE NICHOLS,
Student Assistant in Chemistry.

WILLIAM HOUSTON REBER,
Student Assistant in Civil Engineering.

*MICHAEL SHANFELD,
Student Assistant in Geology and Mineralogy.

†THOMAS ADRIAN STEVENS,
Student Assistant in Physical Training.

†RONALD OWEN SWAYZE,
Student Assistant in Physical Training.

HANLEY WEISER,
Student Assistant in Chemistry.

WALTER CHARLES ZEUCH,
Student Assistant in Physics.

†LAWRENCE JOSEPH ZOLLER,
Student Assistant in Geology and Mineralogy.

*First Semester.
†Second Semester.

OTHER OFFICERS

ROBERT RICHMOND DICKERSON,
Superintendent of Buildings and Grounds.

EDW. KAHLBAUM,
Registrar.

*ETHEL TIFFY,
Assistant Librarian.

†MARGUERITE IRISH,
Assistant Librarian.

ZELLA ELIAS,
Stenographer.

MABEL HAWKINS,
Stenographer.

*Resigned February 15, 1918.
†Appointed May 10, 1918.

FACULTY COMMITTEES

Admission and Advanced Standing.
Dean, Barley and Gottschalk.

Alumni Exchange.
Mann, Clayton, Dean and Garrett.

Athletics.
Cox, Barley, Bowen and Clayton.

Buildings and Grounds.
Harris, Dickerson and Wallis.

Curricula and Degrees.
Gottschalk, Cox, Dickerson and Mann.

Publications.
Barley, Daniels and Wheeler.

Theses.
Harris, Cox, Gottschalk and Mann.

Military Drill.
Muilenburg, Armsby, McRae, Wallis and McConnell.

SPECIAL LECTURES

Professor Duff Andrew Abrams, C. E., Chicago, Illinois, Lewis Institute.

"The Researches of the Association of Portland Cement Manufacturers."

February 14, 1918.

"The Factors Influencing the Strength of Concrete."

February 15, 1918.

Professor Rollo Walter Brown, A. M., Crawfordsville, Indiana, Wabash College.

"Why France Held Fast."

January 30, 1918.

H. A. Buehler, State Geologist, Rolla, Missouri.

"Peculiarities of the Apex Law."

December 18, 1917.

"The Panama Canal," Illustrated.

February 13, 1918.

Professor B. B. Freud, Chicago, Illinois, Armour Institute of Technology.

"Recent Developments in the Manufacture of Synthetic Phenol."

January 21, 1918.

"The Chemist and the Chemical Engineer."

January 22, 1918.

Reverend Guy Willis Holmes, Mansfield, Missouri.

"Opportunities for the Engineer in Cuba."

February 25, 1918.

V. H. Hughes, E. M., Tulsa, Oklahoma, of Valerius, McNutt and Hughes.

"The Economic Importance of the Permian Red Beds."

January 18, 1918.

Professor Chas. E. Locke, B. S., Boston, Massachusetts, Massachusetts Institute of Technology.

"Mining in Korea."

January 23, 1918.

"The Auriferous Sands of the Adirondacks."

January 25, 1918.

Professor Lewis E. Meador, Ph. B., A. M., Springfield, Missouri, Drury College.

"Don't Enlist but Wait for the Draft!"

February 8, 1918.

HISTORY OF THE SCHOOL

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

Object of These Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (Laws 1915, Sec. 11134.)

Right to Confer Degrees.—The college of agriculture and the school of mines and metallurgy shall have power to confer degrees suitable to their designs and courses of study; and the school of mines and metallurgy shall provide courses for, and shall confer the bachelor of science and professional degrees in mining engineering, in metallurgy, in mechanical engineering, in electrical engineering, in chemical engineering, in civil engineering and the degrees of bachelor and master of science in general science. (Laws 1915, Sec. 11141.)

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The statutes fix the status of the school as one of the Colleges of the State University. Its affairs are under the immediate supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body. The need of general culture as a foundation and accompaniment of specifically technical training led to the establishment, in 1885, of an Academic Course in compliance with the following act of the General Assembly:

"Academic Course of Study, Etc.—That the obligation of the State to the General Government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the University of the State of Missouri shall prescribe and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of a bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof." (Revised Statutes, 1909, Section 11135.)

ENDOWMENT

The proceeds from the sale of 275,000 acres of public lands granted to Missouri by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent interest. The School of Mines receives one-fourth of the yearly income thus accruing.

"The proceeds of the sale of lands donated to the State of Missouri by the United States for the support of the College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy, by Act of Congress approved July 2, 1862, represented by State certificates of indebtedness, of the following amounts and dates:

July 2, 1883	$242,000.00
November 1, 1883	5,000.00
January 29, 1884	5,000.00
April 19, 1884	35,000.00
April 2, 1885	5,000.00
February 25, 1886	5,000.00
January 1, 1888	5,000.00
December 15, 1888	5,000.00
May 15, 1889	5,000.00
July 1, 1891	5,000.00
May 15, 1893	5,000.00
July 1, 1895	22,881.19
April 9, 1895	5,000.00
Representing a total of	$349,881.19

Now issued or any certificates which may hereafter be issued under any general or special act of the General Assembly; one-fourth of the interest of these funds shall be paid to the Treasurer of the School of Mines and Metallurgy, at Rolla, for the maintenance of said institution."

"The proceeds of sales of lands donated to the School of Mines and Metallurgy, at Rolla, represented by the State certificate of indebtedness of $2,000, dated April 15, 1893, issued under act of March 31, 1883, interest on which shall be applied to the maintenance of the School of Mines and Metallurgy, at Rolla."

"The State certificate of indebtedness of $3,000, issued under act of April 1, 1895, dated April 1, 1896, four-fifths of the interest to be applied to the maintenance of the State University, at Colum-

bia, and one-fifth to the School of Mines and Metallurgy, at Rolla, and also any other certificate which may hereafter be issued and held in trust for this fund under any general or special act of the General Assembly." (Revised Statutes, 1909, Section 11161.)

In addition to the foregoing, the School of Mines receives one-fourth of the interest on municipal and drainage district bonds amounting to $16,000.00, purchased under authority of Section 11168 of the Revised Statutes of 1909, amended by act approved April 7, 1911, Session Acts, 1911, p. 415.

By an Act of Congress, approved August 30, 1890, commonly known as the "Morrill Bill," the General Government assists each State and Territory in maintaining a college or colleges in accordance with the act of July 2, 1862. After deducting one-sixteenth for the Lincoln Institute, Missouri gives one-fourth of the remainder of this fund to the School of Mines.

"All sums collected under the provisions of an Act of Congress, approved August 30, 1890, commonly known as the 'Morrill Bill,' shall be paid as follows: One-sixteenth thereof for the benefit of the Lincoln Institute and one-fourth of the remainder to the Treasurer of the School of Mines, at Rolla, Missouri." (Revised Statutes, 1909, Section 11171.)

In 1891 the Government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23, and the Thirty-sixth General Assembly of the State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University at Columbia and the School of Mines and Metallurgy at Rolla. One-fifth of the income from this endowment is received by the School of Mines.

"The State certificate of indebtedness of $646,958.23, derived from 'direct tax' received from the United States, dated April 1, 1891, issued under act of March 26, 1891, four-fifths of the interest to be applied for the maintenance of the State University, at Columbia, and one-fifth for the School of Mines and Metallurgy, at Rolla." (Revised Statutes, 1909, Section 11161.)

The Fortieth General Assembly of the State passed an act providing for a tax on collateral inheritances for the benefit of the State University, and the Forty-first General Assembly provided that one-fifth of the funds derived from this tax shall be appropriated for the benefit of the School of Mines.

Collateral Inheritance Tax.—"The moneys received by the State Treasurer under the provisions of this article shall be deposited in the State Treasury to the credit of the fund now existing in the State Treasury and known as the 'State Seminary Moneys' for the maintenance support and better equipment of the buildings, apparatus, books, instruction, etc., of the University of the State of

Missouri, to an amount not exceeding in any one year the equivalent of one-tenth of one mill for every dollar of the assessed valuation of taxable property of the State for the said year: *Provided*, that one-fifth of all such moneys so received shall be devoted to the use of the School of Mines and Metallurgy, a department of the said University." (Revised Statutes, 1909, Section 312.)

LOCATION

The School of Mines is located at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco Railroad, approximately halfway between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above the sea level, and has an agreeable and notably healthful climate. Its position on the great transcontinental railway system makes it readily accessible.

The school is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of mining geology, mining methods, ore dressing, and mining machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores, have given the school advantages for the application of the theories of geology, mining, and ore dressing to practice.

The smelting industry of the State is very important, and every courtesy is extended to the professors and students of the school during their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay-working and cement plants in St. Louis and vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also various chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are over twenty-seven acres in extent. The campus contains beautiful lawns, groves of native oak, and maple shade trees.

The Jackling Field has a good baseball diamond, a football gridiron, tennis courts, and a 440-yard running track.

The new gymnasium is conveniently situated at the east end of the athletic field and is equipped with lockers, shower baths, dressing rooms, swimming pool and the usual gymnastic apparatus.

BUILDINGS

Rolla Building.

This building was originally built by the City of Rolla as a High School building, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, includng a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey, toilet, shower baths, and locker rooms.

Chemical Hall.

The main portion of this building was erected in 1885 and two wings were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five feet by sixty feet and one story high. A stock room twenty-eight feet wide by forty-four feet long, two stories high, was erected in 1915, and is accessible to the qualitative and quantitative laboratories. This entire building, including a large basement, is used for chemistry.

Power Plant.

This building, erected in 1895, is a tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, an instrument room, and laboratories—the other comprising an engine room, a boiler room, and a mechanical engineering laboratory.

Mechanical Hall.

This two-story brick building, erected in 1901, is one hundred fifty feet by sixty feet and was specially designed for mechanical work. The second floor includes a demonstration lecture room and a shop for bench work in wood. The first floor contains a lathe room for wood turning, a forge room, a metal-working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers, and an office for the instructor.

Norwood Hall.

The corner stone of this building was laid November 23, 1902, and the building was first used in 1903. It contains adequate quarters for lecture and recitation rooms for physics, geology, minerology civil engineering, English, mathematics; also drawing rooms and laboratories for physics, geology, mineralogy, civil engineering and mechanical engineering.

Ore Dressing Building.

This is a three-story gray press-brick building with a basement and two large one-story wings. Two stories and the west wing have been in use since January, 1908, and the east wing was erected in 1909. The building provides quarters for metallurgy and ore dressing. The building was completed in 1911 and contains over twenty-five thousand square feet of floor space.

Parker Hall.

This is a fireproof, two-story gray press-brick building, with a well-lighted basement. The main portion of the building is one hundred two by fifty-five feet and the wing is fifty-eight by sixty feet. The library occupies the second story of the building; the administrative offices, faculty room, and board room are located on the first floor; and the assembly room is in the two-story wing. In the basement are the testing machines and the cement laboratories. This building was erected in 1912.

The Gymnasium.

This building, which was completed in 1915, was made possible by the appropriation of seventy thousand dollars by the Forty-seventh General Assembly. The Gymnasium is located at the north end of the campus, in a portion of Main street which was vacated by the city of Rolla for the purpose. The front is to the south, and the west side opens onto Jackling Field.

The building occupies a space seventy-two feet wide and one hundred twenty-seven feet long, and is finished in dark red, rough brick with gray terra-cotta trimmings. The interior is of fireproof construction, with concrete and composition floors, except in the gymnasium proper, which is floored with maple. Tile partitions are used throughout the building, and the roof is concrete, supported by steel trusses and covered with asbestos roofing.

On the ground floor, entered by the main entrance on the south of the building, are the cloakrooms, locker rooms, training quarters and visiting teams' room, shower baths and swimming pool. The

swimming pool is twenty by sixty feet, finished in white enamel and equipped with all modern appliances. The water supplied to the pool is circulated with a small motor-driven pump, and a constant temperature is maintained by passing the water through a special steam boiler.

The mezzanine floor is on a level with Jackling Athletic Field, and opens upon a terrace which parallels the running track. On this floor are committee rooms, general toilet rooms, the auxiliary gymnasium and balcony overhanging the swimming pool. On the second floor is the gymnasium room proper. This room is seventy feet wide by ninety feet long and is well equipped. On this floor also is the examination room, office and reception room.

The gallery of the gymnasium is a running track, with twenty-six laps to the mile. At the south end of the building on the third floor is a large lounging and rest room.

Carpenter Shop.

The general repair work of the school and construction of laboratory equipment is carried on in a frame building, one hundred fifty feet by twenty-two feet. This building is located west of Mechanical Hall, and includes a store room for lumber.

LIBRARY

Harold L. Wheeler, Librarian; Miss Tiffy, Miss Irish, *Mr. Cooper, Mr. Gettler, *Mr. Tidd, *Mr. Richmond, Mr. Norville.

The library occupies the second floor of Parker Hall. Its quarters consist of a large, well-lighted reading room, a stack room equipped with a double-deck Snead stack, capacity 45,000 volumes, and a suite of offices and workrooms for the library staff. All equipment is new and up-to-date, meeting in every way the needs of the library and its clientele.

The collection of books numbers more than 20,000 carefully selected volumes, together with a large collection of pamphlets, bulletins and reports of mining companies. It is constantly increased with reference to the different courses of study, while at the same time there is kept in view the development of a well-rounded general library. The bulk of the collection consists of works in the sciences, chiefly geology, physics, chemistry, and the useful arts, the main part of this division being engineering and mining treatises. During the present year large additions have been made in the fields of organic and industrial chemistry, chiefly due to the kindness of Prof. B. B. Freud of the Armour Institute of Technology, Chicago.

Besides these collections, the library has the representative works in American and English literature, some fiction, a good section of biography, and the latest books of description and travel, the latter division being kept especially strong, so that the students may be informed concerning the manners and customs of the people and the characteristics of the countries into which they are likely to go to follow their vocation.

The library is a subscriber to the standard technical periodicals and the publications and transactions of societies and congresses. The leading general magazines are taken for recreational reading. The contents of the back files of this material is made available through the general periodical indexes, the engineering and mining indexes, and other bibliographic aids.

The Dewey decimal system of classification is used and the resources of the collection are made available through a full dictionary catalogue of authors, titles, and subjects.

*Absent on military service.

READING ROOM LIBRARY

PARKER HALL

Interlibrary loan arrangements exist between this library and the Library of Congress, the St. Louis Public Library, John Crerar Library of Chicago, and the University Library at Columbia. By this arrangement books not in the collection at the School of Mines may be borrowed for the use of the students for a limited time.

The reading room is open daily from 7.45 to 12; 1 to 6, and 7 to 10; Sunday 2 to 5. Books and periodicals may be borrowed by all officers and students of the school, and by others having permission.

ADMISSION

Under the statutes, persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good, liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman class at entrance was about eighteen years. Specific requirements have been fixed by consideration of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries.

Students are admitted in the following ways:

By Certificate:

Applicants who are graduates from fully accredited high schools will be admitted without examination, provided they present a certificate signed by the superintendent or principal showing that the applicant has to his credit fifteen units. Of these units three in English, one and one-half in Algebra, one in Plane Geometry are required.

Graduates of fully accredited high schools who lack credit in the required units must pass an examination to make up such deficiency.

Graduates of partially accredited high schools must pass examination in all of the units in which they are deficient.

By Examination:

Applicants who are not graduates of approved high schools are required to pass examinations in fifteen units as outlined below, a unit being equivalent to a year's work in one subject as given in approved high schools. Conditions may be allowed in two of the fifteen units, but these must be removed within one year from the date of entrance.

Applicants from accredited high schools who are not graduates will not be permitted to enter if they receive conditions in any subject or subjects unless a year or more has elapsed since they attended the high school.

By Advanced Standing:

Applicants may be admitted to advanced standing either upon examination in the subjects of the previous year or years or upon certificate from another institution of work accomplished which, in the estimation of the faculty, is equivalent to that completed here by the class into which entrance is sought. They must also before becoming candidates for degrees present evidence of the satisfactory completion of all entrance requirements into the Freshman class. Every applicant must also present a letter of honorable dismissal from the school last attended. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the students within one semester after entrance.

As Special Students:

Speciai students may be admitted without passing the entrance examination under the following provisions:

1. They must be at least twenty-one years of age.
2. They must show good reasons for not taking a regular course.
3. They must pass such examinations or other tests as shall demonstrate their fitness to pursue profitably all the subjects selected by them.
4. They shall not be candidates for a degree.
5. Special students are expected to do particularly good work in the subjects which they choose. If at any period of the session their work becomes unsatisfactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature, they will be required to take at the same time as much classroom work as the faculty may designate for each particular class.

Definition of Entrance Units.

ENGLISH. (4 Units.)

The four units that may be offered in English include grammar, composition and rhetoric, and literature.

The candidate will be required to show a reasonable proficiency in the principles of English grammar, including sentence-analysis. He will be required to show the ability to express himself coherently and correctly, with a fair mastery of the forms of writing, spelling and punctuation, sentence and paragraph structure. He will be examined on the literature listed below, and, if he desires four units, will be required to show also a knowledge of the history of English literature.

The classics prescribed are as follows:

1915—1919.

For Reading.

Group I.—Classics in Translation. Two to be Selected.—The Old Testament, comprising at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings, and Daniel, together with the books of Ruth and Esther; Homer's Odyssey, with the omission, if desired, of Books I, II, III, IV, V, XV, XVI, XVII; Homer's Iliad, with the omission, if desired, of Books XI, XIII, XIV, XV, XVII, XXI; Virgil's Aeneid. The Odyssey, Iliad, and Aeneid should be read in English translations of recognized literary excellence. For any selection from this group a selection from any other group may be substituted.

Group II.—Shakespeare. Two to be Selected.—Shakespeare's Midsummer-Night's Dream; Merchant of Venice; As You Like It; Twelfth Night; The Tempest; Romeo and Juliet; King John; Richard II; Richard III; Henry V; Coriolanus; Julius Caesar; Macbeth; Hamlet.

N. B.—The last three only, if not chosen for study.

Group III.—Prose Fiction. Two to be Selected.—Malory's Morte d'Arthur (about 100 pages); Bunyan's Pilgrim's Progress, Part I; Swift's Gulliver's Travels (Voyages to Lilliput and to Brobdingnag); Defoe's Robinson Crusoe, Part I; Goldsmith's Vicar of Wakefield; Frances Burney's Evelina; Scott's Novels, any one; Jane Austen's Novels, any one; *either* Maria Edgeworth's Castle Rackrent, *or* The Absentee; Dickens's Novels, any one; Thackeray's Novels, any one; George Eliot's Novels, any one; Mrs. Gaskell's Cranford; *either* Kingsley's Westward Ho! *or* Hereward the Wake; Reade's The Cloister and the Hearth; Blackmore's Lorna Doone; Hughes' Tom Brown's Schooldays; *either* Stevenson's Treasure Island, Kidnapped, or The Master of Ballantrae, Cooper's Novels; any one; Poe's Selected Tales; *either* Hawthorne's The House of the Seven Gables, *or* Twice Told Tales, *or* Mosses from an Old Manse; A collection of short stories by various standard writers.

Group IV.—Essays, Biography, Etc. Two to be Selected.—*Either* the Sir Roger de Coverley Papers, *or* Selections from The Tatler and The Spectator (about 200 pages); Boswell's Selections from the Life of Johnson (about 200 pages) Franklin's Autobiography; *either* Irving's Selections from the Sketch Book (about 200 pages), *or* The Life of Goldsmith; Southey's Life of Nelson; Lamb's Selections from the Essays of Elia (about 100 pages); Lockhart's Selections from the Life of Scott (about 200 pages); Thackeray's Lectures on Swift, Addison and Steele in

the English Humorists; Macaulay: one of the following essays: Lord Clive, Warren Hastings, Milton, Addison, Goldsmith, Frederic the Great, *or* Madame d'Arblay; Trevelyan's Selections from Life of Macaulay (about 200 pages); *either* Ruskin's Sesame and Lilies, *or* Selections (about 150 pages); Dana's Two Years Before the Mast; Lincoln's Selections, including at least the two Inaugurals, the Speeches in Independence Hall and at Gettysburg, the Last Public Address, *and* Letter to Horace Greeley, together with a brief memoir or estimate of Lincoln; Parkman's The Oregon Trail; Thoreau's Walden; Lowell's Selected Essays (about 150 pages); Holmes's The Autocrat of the Breakfast Table; Stevenson's Inland Voyage, *and* Travels with a Donkey; Huxley's Autobiography *and* selections from Lay Sermons, including the addresses on Improving Natural Knowledge, A Liberal Education, *and* A Piece of Chalk; A collection of Essays by Bacon, Lamb, De Quincey, Hazlitt, Emerson, and later writers; A collection of Letters by various standard writers.

Group V.—Poetry. Two to be Selected.—Palgrave's Golden Treasury (First Series): Books II and III, with special attention to Dryden, Collins, Gray, Cowper, and Burns; Palgrave's Golden Treasury (First Series): Book IV, with special attention to Wordsworth, Keats, and Shelley (if not chosen for study); Goldsmith's The Traveller, and The Deserted Village; Pope's The Rape of the Lock; A Collection of English and Scottish Ballads, as for example, some Robin Hood ballads, The Battle of Otterburn, King Estmere, Young Beichan, Bewick and Grahame, Sir Patrick Spens, and a selection from later ballads; Coleridge's The Ancient Mariner, Cristabel, and Kubla Khan; Byron's Childe Harold, Canto III or IV, and The Prisoner of Chillon; either Scott's The Lady of the Lake or Marmion; Macaulay's The Lays of Ancient Rome, The Battle of Naseby, The Armada, Ivry; either Tennyson's The Princess, or Gareth and Lynette, Lancelot and Elaine, and The Passing of Arthur; Browning's Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Home Thoughts from Abroad, Home Thoughts from the Sea, Incidents of the French Camp, Herve Riel, Pheidippides, My Last Duchess, Up at a Villa— Down in the City, The Italian in England, The Patriot, "De Gustibus—," The Pied Piper, Istans Tyrannus; Arnold's Sohrab and Rustum, and The Forsaken Merman; Selections from American Poetry, with special attention to Poe, Lowell, Longfellow, and Whittier.

For Study.

Group I.—Drama. One to be Selected.—Shakespeare's Julius Caesar, Macbeth, Hamlet.

Group II.—Poetry. One to be Selected.—Milton's L'Allegro, Il Penseroso, and either Comus or Lycidas; Tennyson's The

Coming of Arthur, The Holy Grail, and the Passing of Arthur; The selections from Wordsworth, Keats, and Shelley in Book IV of Palgrave's Golden Treasury (First Series).

Group III.—Oratory. One to be Selected.—Burke's Speech on Conciliation with America; Macaulay's Two Speeches on Copyright, and Lincoln's Speech at Cooper Union; Washington's Farewell Address, and Webster's First Bunker Hill Oration.

Group IV.—Essays, One to be selected.—Carlyle's Essay on Burns, with a selection from Burns' Poems; Macaulay's Life of Johnson; Emerson's Essay on Manners.

MATHEMATICS. (4 Units.)

The four units which may be offered in mathematics are as follows:

Algebra. (1½ Units.) Elementary algebra, including the elementary operations, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and coefficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomial theorem for positive integral exponent, ratio and proportion, and logarithms.

While the study of these particular subjects is recommended, it is not expected that the student shall be able to pass an examination on each and every one of them.

Plane Geometry. (1 Unit.) The work in plane geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of algebra to geometry, and of geometry to algebra and arithmetic.

Solid Geometry. (1½ Unit.) The same recommendations apply here as in plane geometry.

Trigonometry. (1 Unit.) It is to be understood at the outset that this work will not be accepted for advanced standing. This branch of mathematics is of such great importance to the practical engineer that the whole subject must be reviewed and the student led to a point of view which it is impossible to attain in a high school course.

HISTORY.

Four units may be offered in history; one each in Ancient History, Medieval and Modern History, English History, and American History.

CIVIL GOVERNMENT.

One-half unit may be offered in Civil Government. This is the equivalent of one-half year's work in the fourth year of a high school, and the applicant should have a knowledge of the chief organs of local, state, and national government and a knowledge of the historical development of the government.

Physiography.

A student may offer one unit in physiography. A description of this unit will be sent on request.

PHYSICS.

The two units that may be offered in physics are as follows:

1. A year's work, five periods per week, of which at least two must be double periods in individual laboratory work. At least thirty-five exercises, selected from a list of sixty or more, equivalent to those recommended by the National Educational Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory notebooks must be presented by those who are required to take the entrance examination.

DRAWING.

Two units may be offered.

MANUAL TRAINING.

Two units in manual training may be offered. One unit should be in Bench Work and one in Mechanical Drawing. The time required in each of these subjects is five double periods for one year or five single periods for two years. Where conditions permit it is generally advisable to give these subjects as parallel courses.

LATIN.

The four units that may be offered in Latin are as follows:

1. Collar and Daniel's First Latin Book, or the equivalent.

2. Three books of Caesar's Gallic War with composition based thereon in Moulton and Collar's Preparatory Latin Composition or in Daniel's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romae, Nepos, or Eutropius may be offered.

3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.

4. Ovid's Metamorphoses (2,000 lines) and four books of Virgil's Aeneid, with prosody.

GREEK.

The three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten Orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman's Parallel Exercises based on Lysias.

GERMAN, FRENCH, SPANISH.

Three units may be offered in German, French, or Spanish. A description of the units will be sent on request. These units will not be accepted for advanced standing.

CHEMISTRY.

The two units that may be offered in chemistry are as follows:

1. A year's work in chemistry, five periods per week, of which at least two must comprise laboratory work.

2. A second year's work in the subject, five periods per week, of which at least two must be laboratory work.

Notebooks showing work done must be presented by those who are required to take the entrance examinations.

These courses will be accepted for admission, but not for advanced standing.

BOOKKEEPING.

One unit may be offered.

COMMERCIAL GEOGRAPHY.

One-half unit may be offered.

Following is a list of schools whose courses have been approved by the University and whose diplomas will admit to the Freshman class without examination.

ACCREDITED SCHOOLS IN MISSOURI*

FULLY ACCREDITED SCHOOLS

Academy of the Visitation (St. Louis.)
Adrian High School
Albany High School
Anderson High School
Appleton City High School
Armstrong High School
Ash Grove High School
Aurora High School
Ava High School
Belton High School
Bethany High School
Bevier High School
Billings High School
Bloomfield High School
Bolivar High School
Bonne Terre High School
Boonville High School
Bosworth High School
Bowling Green High School
Braymer High School
Breckenridge High School
Brookfield High School
Brunswick High School
Buffalo High School
Bunceton High School
Burlington Junction High School
Butler High School
Cainesville High School
California High School
Cameron High School
Campbell High School
Cape Girardeau High School
Carrollton High School
Carterville High School
Carthage High School
Caruthersville High School
Centralia High School
Charleston High School
Chillicothe High School
Clarence High School
Clayton High School
Clinton High School
Cole Camp High School
Columbia High School
Craig High School
Dearborn High School
De LaSale Academy (Kansas City)
Desloge High School
DeSoto High School
Dexter High School
Doniphan High School
East Prairie High School
Edgerton High School
Edina High School
Eldon High School
Eldorado Springs High School
Elsberry High School
Eolia High School
Everton High School
Excelsior Springs High School
Fairfax High School
Farmington High School
Fayette High School
Ferguson High School.

*Certificates will be accepted from high schools in other states which are affiliated with their respective State Universities provided these are of similar rank with the University of Missouri.

Festus High School
Flat River High School
Fredericktown High School
Fulton High School
Gallatin High School
Garden City High School
Gilman City High School
Glasgow High School
Golden City High School
Gorin High School
Grant City High School
Green City High School
Greenfield High School
Greenville High School
Hale High School
Hamilton High School
Hannibal High School
Hardin High School
Harrisonville High School
Hayti High School
Higbee High School
Higginsville High School
Holden High School
Hopkins High School
Hosmer Hall (St. Louis)
Houston High School
Huntsville High School
Iberia Academy (Iberia)
Independence High School
Ironton High School
Jackson High School
Jamesport High School
Jasper High School
Jefferson City High School
Joplin High School
Kahoka High School
Kansas City Central High School
Kansas City Manual Training High School
Kansas City Northeast High School
Kansas City Westport High School
Kemper Military School Boonville)
Kennett High School
Kendrick Catholic Boys' High School (St. Louis)
Keytesville High School
Kidder Institute (Kidder)
Kirksville High School
Kirkwood High School
Knobnoster High School
Knox City High School
LaBelle High School
Laclede High School
Lamar High School
Lancaster High School
La Plata High School
Lebanon High School
Lees Summit High School
Lenox Hall (St. Louis)
Lexington High School
Liberty High School
Lockwood High School
Loretto Academy (Kansas City)
Louisiana High School
Macon High School
Maitland High School
Malden High School
Maplewood High School
Marceline High School
Marionville High School
Marshall High School
Marshfield High School
Mary Institute (St. Louis)
Maryville High School
Maysville High School
Meadville High School
Memphis High School
Mexico High School
Milan High School
Moberly High School
Monett High School
Monroe City High School
Montgomery City High School
Mound City High School
Mountain Grove High School
Mt. Vernon High School
Neosho High School
Nevada High School
New Franklin High School
New Hampton High School

New Haven High School
New London High School
Norborne High School
Oak Grove High School
Odessa High School
Oregon High School
Osceola High School
Otterville High School
Ozark High School
Palmyra High School
Paris High School
Pattonsburg High School
Perry High School
Perryville High School
Piedmont High School
Pierce City High School
Platte City High School
Plattsburg High School
Pleasant Hill High School
Polo High School
Poplar Bluff High School
Potosi High School
Princeton High School
Principia, The (St. Louis)
Republic High School
Rich Hill High School
Richmond High School
Ridgeway High School
Rockport High School
Rolla High School
Rosati-Kain High School (St. Louis)
St. Charles High School
Ste. Genevieve High School
St. James High School
St. Joseph Benton High School
St. Joseph Central High School
St. Joseph's Academy (St. Louis)
St. Louis Central High School
St. Louis Cleveland High School
St. Louis McKinley High School
St. Louis Soldan High School
St. Louis Yeatman High School
St. Teresa's Academy (Kansas City)
St. Vincent's Academy (Kansas City)
Salem High School
Salisbury High School
Sarcoxie High School
Savannah High School
Sedalia High School
Seymour High School
Shelbina High School
Shelbyville High School
Sikeston High School
Skidmore High School
Slater High School
Smith Academy (St. Louis)
Smithville High School
Springfield High School
Stanberry High School
Steelville High School
Sturgeon High School
Sullivan High School
Sweet Springs High School
Tarkio High School
Tipton High School
Trenton High School
Troy High School
Union High School
Unionville High School
Vandalia High School
Versailles High School
Walnut Grove High School
Warrensburg High School
Warsaw High School
Washington High School
Webb City High School
Webster Groves High School
Wellston High School
Wellsville High School
Wentworth Military Academy (Lexington)
Weston High School
West Plains High School
Will Mayfield Academy (Marble Hill)
Willow Springs High School
Windsor High School
Wyaconda Consolidated High School

CURRICULA

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged for the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The curricula are the same in the Freshman year and differ but slightly in the Sophomore year. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

One hour is given to each recitation or lecture period. The afternoon periods are given to drawing, laboratory, and field work, and are of three hours' duration; one laboratory period of three hours is rated as equivalent to one and one-half credits.

The School of Mines and Metallurgy offers the following curricula:

I. Mine Engineering, leading to the degree of Bachelor of Science in Mine Engineering. This is a general course in Mine Engineering, having in view all the operations in connection with mining from the prospecting to the delivery of the finished product on the market.

II. Metallurgy, leading to the degree of Bachelor of Science in Metallurgy. This curriculum contemplates especially processes in Metallurgy subsequent to the delivery of ore above ground.

III. Civil Engineering, leading to the degree of Bachelor of Science in Civil Engineering. This is a curriculum in engineering as applied especially to railways, highways, and municipal works.

IV. General Science, leading to the degree of Bachelor of Science in General Science. This curriculum is largely elective and provides for a liberal education in science.

V. Mechanical Engineering, leading to the degree of Bachelor of Science in Mechanical Engineering. This curriculum applies especially to mechanical engineering in shops, mills, ore dressing plants and power plants.

VI. Electrical Engineering, leading to the degree of Bachelor of Science in Electrical Engineering. This is a general course in electrical engineering fitting a man for positions in power plants, transmission plants, central stations and electric railways. The curriculum is so arranged that electives may be chosen in electro-chemistry and electro-metallurgy thus fitting a man for the position of electrical engineer in chemical works and metallurgical plants.

VII. Chemical Engineering, leading to the degree of Bachelor of Science in Chemical Engineering. This curriculum is intended for those who desire to fit themselves for the management of industrial plants in which a knowledge of the principles and methods of chemical analysis and the fundamentals of engineering are required.

VIII. Graduate Curriculum in Mine Engineering, leading to the degree of Engineer of Mines. The curriculum is open to Bachelors of Science in Mine Engineering.

IX. Graduate Curriculum in Metallurgy, leading to the degree of Metallurgical Engineer. This curriculum is open to Bachelors of Science in Metallurgy.

GRADUATE COURSES

The School of Mines offers graduate work in Mining Engineering, Metallurgy, Ore Dressing, Geology, Economic Geology, Petrography, and Advanced Chemistry. The attention of graduates of engineering schools and of mining schools is directed to the following courses:

- Mine Management
- Mining Machinery
- Mining Machinery Laboratory
- Mining Law
- Mine Examination and Reports
- Mine Plant
- Mine Plant Design
- Mine Power Plant
- Mining Economics
- Economic Geology
- Geology of the United States
- Structural and Metamorphic Geology
- Petrography
- Petrography Laboratory
- Cement and Concrete Structures
- Compressed Air
- Compressed Air Laboratory
- Engineering Designs
- Ore Dressing Laboratory
- Ore Dressing Problems
- Ore Supply
- Metallurgy Organization
- Metallography
- Constitution of Alloys
- Metallurgical Problems
- Metallurgical Plant
- Metallurgical Plant Design
- Cyaniding
- Electro-Metallurgy
- Electro-Metallurgy Laboratory
- Metallurgical Research
- Electro-Chemistry
- Water Analysis
- Physical Chemistry
- Theoretical Chemistry
- Advanced Physico-Chemical Laboratory
- Internal Combustion Engines

Graduates from the four-year curriculum in Mining Engineering may pursue graduate work leading to the degree of Engineer of Mines. Electives may be chosen along any line approved by the Faculty.

A similar graduate curriculum is offered in Metallurgy. This leads to the degree of Metallurgical Engineer.

SPECIAL COURSES

In addition to the regular curricula leading to degrees, before mentioned, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying, and Electricity.* They have been planned for the benefit of those who for various legitimate reasons are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* requires two years' work, although mature students, who have already some knowledge of chemistry, may complete it in one year.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draftsmen. The essentials of it are a thorough knowledge of algebra, trigonometry, surveying, field practice, and drawing. One school year and the first term of a second year will be required for the completion of this course.

A short course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides mathematics this course includes general chemistry, assaying, mineralogy, mining, surveying and English.

A course in *Electricity* is offered to furnish the student with the theory of electricity and acquaint him with its application in the arts. This subject is of great importance to every engineer, especially to the mining engineer, since electricity has become such an important factor in mining operations.

DEGREES

I. The degree of Bachelor of Science in Mine Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum I., and all of the required trips of Curriculum I. The final year's work must be done in residence.

II. The degree of Bachelor of Science in Metallurgy will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum II., and all of the trips required in Curriculum II. The final year's work must be done in residence.

III. The degree of Bachelor of Science in Civil Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum III. The final year's work must be done in residence.

IV. The degree of Bachelor of Science in General Science will be conferred upon a candidate who has completed the prescribed work of Curriculum IV. Candidates for degrees in General Science must matriculate in General Science Curriculum not later than the beginning of the second semester of the sophomore year. The final year's work must be done in residence.

V. The degree of Bachelor of Science in Mechanical Engineering will be conferred upon a candidate who has completed the prescribed work of Curriculum V. The final year's work must be done in residence.

VI. The degree of Bachelor of Science in Electrical Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum VI. The final year's work must be done in residence.

VII. The degree of Bachelor of Science in Chemical Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum VII. The final year's work must be done in residence.

VIII. The degree of Engineer of Mines, Metallurgical Engineer, will be conferred upon a candidate who holds a degree ol Bachelor of Science in Mine Engineering or Bachelor of Science in Metallurgy, respectively, and who has completed, in residence, one year of post graduate work.

IX. The degree of Engineer of Mines, Metallurgical Engineer, Civil Engineer, Mechanical Engineer, Electrical Engineer, or Chemical Engineer will be conferred upon a candidate who holds a degree of Bachelor of Science in Mine Engineering, Bachelor of Science in Metallurgy, Bachelor of Science in Civil Engineering,

Bachelor of Science in Mechanical Engineering, Bachelor of Science in Electrical Engineering, or Bachelor of Science in Chemical Engineering who has had professional experience in a responsible position for not less than three years. A satisfactory thesis recording the result of some original investigation or independent research in a subject connected with his work, accompanied by such drawings as may be necessary to illustrate it, is required of each candidate for an advanced degree.

A candidate for a professional degree is required to submit a list of companies for whom he has worked, with the positions held, the kind of work done, and the length of service.

When a candidate's professional work has been along another line than that in which he received his college training, he may receive the professional degree in that line after five years of practice and by complying with the foregoing statements concerning detailed report of employment and thesis. This applies only to graduates in I., II., III., V., VI., and VII.

Only one professional degree will be allowed for work done *in absentia*.

X. The degree of Master of Science will be conferred only upon graduates in General Science who have completed a year's graduate work in residence and demonstrated ability by research work and a thesis. Each candidate who is not a graduate of this institution in Curriculum IV. must satisfy the language requirements of Curriculum IV., in addition to completing the graduate requirements. A candidate who is not giving his entire time to graduate study will be unable to earn the degree in one year's residence.

THESES

Seniors may elect, subject to the approval of the head of the Department, to carry on special investigations embodying the results of their work in a thesis. The subject of the thesis must be reported to the Thesis Committee of the Faculty and approved not later than February first. The completed thesis must be filed with the Director not later than May twentieth.

The finished thesis should be typewritten (or printed) on eight and one-half by eleven-inch paper, written on one side only. The paper should be strong linen, unruled and without marginal lines.

The thesis should be typewritten so as to have a margin all around of not less than one and one-half inches.

Thesis paper should not be punched with holes for staples.

Thesis, when submitted, should not be stapled, sewed, or bound in any manner, but should be on loose sheets, in order that all theses may be bound uniformly by the Library.

Drawings, tracings, blue prints, diagrams, statistical tables, etc., when on a single 8½x11 inch sheet, should allow a margin of at least 1½ inches on the inner (long) edge, for binding puposes. When on a larger sheet, requiring folding, large margin should be allowed on all sides, and drawings should not be folded but submitted flat or rolled, in order that they may be properly folded and adjusted by the binder. It is suggested that students confer with the Librarian in regard to the preparation of drawings, diagrams, tracings, etc.

The thesis should have:

(1) A title page containing the subject of the thesis, the writer's name, and the date. It should show the approval of the professor under whose direction the work has been done and should also state the degree for which the candidate is an applicant.
(2) A table of contents.
(3) A list of illustrations.
(4) The body of the thesis including illustrations.
(5) A bibliography.
(6) An index.
(7) Original drawings or tracings.

All theses submitted by candidates for degrees become the property of the School of Mines and Metallurgy and may not be pubished without its approval.

I. MINE ENGINEERING CURRICULUM.

Department.	No.	Course.	Page.	Hrs. per week. Lect.	Lab.	Hours credit.
FRESHMAN YEAR.						
First Semester.						
Chemistry	1f	General Chemistry	54	4	....	4
Chemistry	2f	Chemistry Laboratory	54	....	3	1½
English	1f	Rhetoric and Composition	76	3	....	3
Modern Languages*	7f	German	78			
Modern Languages*	11f	French, or	79	3	....	3
Modern Languages*	15f	Spanish	79			
Mathematics	1f	College Algebra	89			
Mathematics	3f	Plane Trigonometry	89	5	....	5
Mechanical Engineering	2f	Mechanical Drawing	97	....	5	2½
Mechanical Engineering	12f	Woodwork	100	....	4	2.
Military Drill	......	......	118	....	3	0
Second Semester.						
Chemistry	1w	General Chemistry	54	3	....	3
Chemistry	2w	Chemistry Laboratory	54	....	3	1½
English	1w	Rhetoric and Composition	76	3	....	3
Modern Languages	7w	German	78			
Modern Languages	11w	French, or	79	3	....	3
Modern Languages	15w	Spanish	79			
Mathematics	5w	Spherical Trigonometry	89			
Mathematics	7w	Analytical Geometry	90	5	....	5
Mechanical Engineering	1w	Descriptive Geometry	97	1	3	2½
Mechanical Engineering	2w	Mechanical Drawing	97	....	3	1½
Mechanical Engineering	14w	Forge Shop	100	....	3	1½
Military Drill	......	......	118	....	3	0

*Students intending to pursue Curriculum IV (see page 46) should take either French or German to satisfy the Language requirement; those looking forward to Curriculum VII (see page 51) are strongly advised to take German or French.

I. MINE ENGINEERING CURRICULUM—*Continued.*

DEPARTMENT.	No.	COURSE.	Page.	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit.
SOPHOMORE YEAR.						
FIRST SEMESTER.						
Chemistry	4f	Qualitative Analysis	55	....	6	3
Civil Engineering	2f	Plane Surveying	68	....	6	3
English	3f	English Prose	76	3	....	3
Geology and Mineralogy	1f	Mineralogy	82	1	3	2½
Mathematics	9f	Differential Calculus }	90			
Mathematics	11f	Integral Calculus }	90	4	....	4
Physics	1f	General Physics	128	3	....	3
Physics	2f	Physics Laboratory	128	....	3	1½
Military Drill	....	....	118	....	3	0
SECOND SEMESTER.						
Chemistry	6w	Quantitative Laboratory	56	....	6	3
English	3w	English Prose	77	2	....	2
Geology and Mineralogy	1w	Mineralogy	82	1	6	4
Mathematics	11w	Integral Calculus }	90			
Mathematics	13w	Differential Equations }	90	4	....	4
Mechanics	17w	Mechanics	94	4	....	4
Physics	3w	General Physics	129	3	....	3
Physics	4w	Physics Laboratory	129	....	3	1½
Military Drill	....	....	118	....	3	0
JUNIOR YEAR.						
FIRST SEMESTER.						
Chemistry	6f	Quantitative Laboratory	56	....	6	3
Civil Engineering	7f	Railroad Surveying	69	1	3	2½
Geology and Mineralogy	3f	General Geology	83	3	....	3
Mechanics	19f	Mechanics of Materials	94	4	....	4
Metallurgy	1f	Fire Assaying	106	2	....	2
Metallurgy	2f	Assaying Laboratory	107	....	6	3
Mining	3f	Mining	122	3	....	3
Mining	16f	Mining Laboratory	124	....	3	1½
SECOND SEMESTER.						
Geology and Mineralogy	3w	General Geology	83	3	....	3
Geology and Mineralogy	4w	Geology Laboratory	83	....	6	3
Geology and Mineralogy	5w	Lithology	84	1	3	2
Mechanical Engineering	5w	Boilers and Engines	98	3	....	3
Mechanical Engineering	8w	Mechanical Laboratory	99	....	6	3
Metallurgy and Ore Dressing	39w	General Metallurgy	116	3	....	3
Mining	5w	Mine Surveying	122	2	....	2
Mining	6w	Mine Surveying Laboratory	123	....	3½	1

I. MINE ENGINEERING CURRICULUM—*Continued.*

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
SENIOR YEAR.						
First Semester.						
Geology and Mineralogy	9f	Economic Geology	84	4	....	4
Metallurgy and Ore Dressing	5f	Metallurgy	108	4	....	4
Metallurgy and Ore Dressing	6f	Metallurgy Laboratory	110	....	3	1
Metallurgy and Ore Dressing	33f	Ore Dressing	115	3	....	3
Physics and E. E	7f	Principles of E. E	129	3	....	3
Physics and E. E	8f	Dynamo Laboratory	130	....	3	1½
Electives	....	....	....	....	....	4
Second Semester.						
Geology and Mineralogy or	9w	Economic Geology	85			
Metallurgy and Ore Dressing	5w	Metallurgy	110			
Metallurgy and Ore Dressing	33w	Ore Dressing	115	4	....	4
Metallurgy and Ore Dressing	36w	Ore Dressing Laboratory	116	....	6	3
Mining	11w	Mining	123	3	....	3
Mining	19w	Economics and Contracts	124	2	....	2
Physics and E. E	7w	Principles of E. E	129	3	....	3
Physics and E. E	8w	Dynamo Laboratory	130	....	3	1
Electives	....	....	....	....	....	1½

Between the Junior and Senior year students in curricula I must take the Junior Trip, Mining 38.

Electives must be selected from the following courses: Civil Engineering 9f: English and Modern Language 17f, 17w, 19f; Mechanical Engineering 3f, 9f, 11f, 18w; Metallurgy and Ore Dressing 13f, 41w.

Those who wish to specialize in coal mining may omit Metallurgy and Economic Geology and take mine ventilation and Power Plants as required courses, and may have fuel analysis added to the list of electives.

Those who wish to specialize in Geology may omit Metallurgy, Principles of Electrical Engineering, and Dynamo Laboratory and take Field Geology and Structural Geology as required courses and may have Geology of the United States, Oil and Gas, Geology Conference and Petrography added to the list of electives.

II. METALLURGY CURRICULUM.

Freshman year is the same as Curriculum I.
Sophomore year either Curriculum I or Curriculum VII.

Department.	No.	Course.	Page......	Hrs. per week. Lect..	Hrs. per week. Lab...	Hours credit...
JUNIOR YEAR.						
First Semester.						
Chemistry	6f	Quantitative Laboratory	58	....	6	3
Chemistry	35f	Physical Chemistry	64	3	....	3
Chemistry	36f	Physical Chemistry	64	....	6	3
Geology and Mineralogy	3f	General Geology	83			
or				3	....	3
Chemistry	15f	Eng. Chemistry	58			
Mathematics	19f	Mechanics of Materials	94	4	....	4
Physics and E. E	7f	Principles of E. E	129	3	....	3
Civil Engineering	7f	Railroad Surveying	69	1	3	2½
or Physics and E. E	8f	Dynamo Laboratory	130	....	5	2½
Second Semester.						
Chemistry	25w	Electrochemistry	57	2	....	2
Chemistry	26w	Electrochemistry	63	....	6	3
Metallurgy and Ore Dressing	1w	Assaying	106	2	....	2
Metallurgy and Ore Dressing	2w	Assaying Laboratory	107	....	9	4½
Metallurgy and Ore Dressing	41w	Iron and Steel	117	3	....	3
Metallurgy and Ore Dressing	39w	General Metallurgy	116	3	....	3
Metallurgy and Ore Dressing	40w	General Metallurgy	116	....	3	1½
Physics and E. E	7w	Principles of E. E	129	3	....	3

SENIOR YEAR.—Fourteen lectures and fifteen laboratory hours each semester, and the Junior Trip. Metallurgy and Ore Dressing 5f, 5w, 6f, 33f, and 33w, and the Senior Trip must be included. All electives must be approved by the Department of Metallurgy.

III. CIVIL ENGINEERING CURRICULUM.

The Freshman year is the same as in Curriculum I.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
SOPHOMORE YEAR.						
First Semester.						
Civil Engineering	1f	Plane Surveying	68	2	....	2
Civil Engineering	4f	Plane Surveying	69	....	9	4½
English	3f	English Prose	77	3	....	3
Modern Languages	9f	Advanced German	79			
Modern Languages	13f	Advanced French	80	3	....	3
Modern Languages	17f	Advanced Spanish	80			
Mathematics	9f	Differential Calculus	91	4	....	4
Mathematics	11f	Integral Calculus				
Physics	1f	General Physics	129	2	....	3
Physics	2f	Physics Laboratory	129	....	3	1½
Military Drill	......	......	118	....	3	0
Second Semester.						
Civil Engineering	4w	Advanced Surveying	69	....	6	3
Civil Engineering	6w	Civil Engineering Drawing	70	....	3	1½
English	3w	English Prose	78	....	....	2
Modern Languages	9w	Advanced German	79			
Modern Languages	13w	Advanced French	80	....	....	2
Modern Languages	17w	Advanced Spanish	81			
Mathematics	11w	Integral Calculus	91	....	....	4
Mathematics	13w	Differential Equations				
Mathematics	17w	Mechanics	93	....	....	4
Physics	3w	General Physics	129	....	....	3
Physics	4w	Physics Laboratory	129	....	3	1½
Military Drill	......	......	118	....	3	0

III. CIVIL ENGINEERING CURRICULUM—*Continued.*

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
JUNIOR YEAR.						
First Semester.						
Civil Engineering	7f	Railroad Surveying	70	1	3	2½
Civil Engineering	8f	Railroad Surveying	70	....	3	1½
Civil Engineering	9f	Hydraulics	71	3	3	4½
Civil Engineering	11f	Masonry Construction	71	....	3	3
Civil Engineering	20f	Materials Laboratory	72	....	6	3
Geology and Mineralogy	2f	Mineralogy	83	....	3	1½
Geology and Mineralogy	19f	General Geology	88	1	....	1
Mathematics	19f	Mechanics of Materials	93	4	....	4
Second Semester.						
Civil Engineering	7w	Railroad Surveying	70	1	3	2½
Civil Engineering	11w	Reinforced Concrete	71	3	....	3
Civil Engineering	13w	Roads and Pavements	71	....	....	3
Civil Engineering	15w	Stresses	72	2	6	5
Civil Engineering	23w	Railroad Economics	74	2	....	2
Geology and Mineralogy	21w	General Geology	88	2	....	2
Geology and Mineralogy	22w	Geology Laboratory	89	....	6	3
SENIOR YEAR.						
First Semester.						
Civil Engineering	15f	Framed Structures	72	3	6	6
Civil Engineering	19f	Water Supply	72	3	....	3
Civil Engineering	31f	Masonry Design	74	3	6	6
		Electives	....	....	....	6
Second Semester.						
Civil Engineering	32w	Designing	75	....	9	4½
Civil Engineering	29w	Sanitary Engineering	74	3	....	3
Civil Engineering	33w	Municipal Economics	75	2	....	3
Civil Engineering	17w	Contracts	72	2	....	2
		Electives	....	....	....	8½

Electives must be selected from the following courses: Irrigation, Mining, Mine Surveying, Metallurgy of Iron and Steel, Principles of Electrical Engineeting, Dynamo Laboratory, Engineering Writing, City Planning, Landscape Engineering, Compressed Air, Boilers and Engines.

IV. GENERAL SCIENCE CURRICULUM.

The Freshman Year is the same as in I.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
SOPHOMORE YEAR.						
First Semester.						
Chemistry	4f	Qualitative Laboratory	55	....	6	3
English and	3f	English Prose	76	3	....	3
Modern Languages	9f	Advanced German, or	78			
Modern Languages	13f	Advanced French	79	3	....	3
Geology and Mineralogy	1f	Mineralogy	82	1	3	2½
Mathematics	9f	Differential Calculus	90			
Mathematics	11f	Integral Calculus	90	4	....	4
Physics	1f	General Physics	128	3	....	3
Physics	2f	Physics Laboratory	128	....	3	1½
Military Drill	......	....	118	....	3	0
Second Semester.						
English	3w	English Prose	77	2	....	2
Modern Languages	9w	Advanced German or	78			
Modern Languages	13w	Advanced French	79	2	....	2
Physics	3w	General Physics	129	3	....	3
Physics	4w	Physics Laboratory	129	....	3	1½
		Electives	....	....	....	13½
Military Drill	......	....	118	....	3	0
JUNIOR YEAR.						
First Semester.						
English	5f	Shakespeare	77	3	....	3
		Electives	....	....	....	18
Second Semester.						
English	5w	Contemporary Drama	77	3	....	3
		Electives	....	....	....	18

Senior Year, 21 Electives each semester.

In making up his electives in Curriculum IV, the student must select a major field and a minor field. In the former, he is required to complete 50 credit hours and in the latter 25 credit hours. Twelve hours are freely elective.

The student shall choose his major and minor at the beginning of the second semester of the Sophomore Year, and his schedule must be approved by the heads of the departments in whose fields he proposes to study.

V. MECHANICAL ENGINEERING CURRICULUM.

The Freshman Year is the same as in I.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
SOPHOMORE YEAR.						
First Semester.						
Civil Engineering	2f	Plane Surveying	68	....	6	3
English	3f	English Prose	76	3	....	3
Mathematics	9f	Differential Calculus	90			
Mathematics	11f	Integral Calculus	90	4	....	4
Mechanical Engineering	4f	Machine Drawing	98	....	3	1½
Mechanical Engineering	16f	Foundry	101	....	3	1½
Physics	1f	General Physics	128	3	....	3
Physics	2f	Physics Laboratory	128	....	3	1½
		Elective	....	....	....	3
Military Drill	....	....	118	....	3	0
Second Semester.						
Chemistry	34w	Fuel Analysis	64	....	3	1½
English	3w	English Prose	76	2	....	2
Mathematics	11w	Integral Calculus	90			
Mathematics	13w	Differential Equations	90	4	....	4
Mechanical Engineering	18w	Machine Shop	102	....	6	3
Mechanics	17w	Mechanics	94	4	....	4
Physics	3w	General Physics	129	3	....	3
Physics	4w	Physics Laboratory	129	....	3	1½
		Elective	....	....	....	2
Military Drill	....	....	118	....	3	0

V. MECHANICAL ENGINEERING CURRICULUM—*Continued.*

Department.	No.	Course.	Page.	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit.
JUNIOR YEAR.						
First Semester.						
Civil Engineering	9f	Hydraulics	70	3	3	4½
Mathematics	19f	Mechanics of Materials	94	4	....	4
Mechanical Engineering	3f	Mechanism	98	3	....	3
Mechanical Engineering	5f	Boilers and Engines	98	3	....	3
Mechanical Engineering	20f	Machine Design	102	....	6	3
		Electives	....	....	....	4
Second Semester.						
Civil Engineering	20w	Materials Laboratory	73	....	3	1½
Mechanical Engineering	7w	Valve Gears	99	2	....	2
Mechanical Engineering	8w	Mechanical Laboratory	99	....	6	3
Mechanical Engineering	9w	Thermodynamics	100	3	....	3
Mechanical Engineering	20w	Engine Design	103	....	6	3
Metallurgy and Ore Dressing	41w	Metallurgy of Iron and Steel	117	3	....	3
		Electives	....	....	....	5
SENIOR YEAR.						
First Semester.						
Mechanical Engineering	9f	Power Plants	99	3	3	4½
Mechanical Engineering	24f	Power Plant Design	103	....	6	3
Physics and E. E	7f	Principles of E. E	129	3	....	3
Physics and E. E	8f	Dynamo Laboratory	130	....	3	1½
		Electives	....	....	....	13
Second Semester.						
Mechanical Engineering	19w	Industrial Engineering	102	3	....	3
Civil Engineering	17w	Contracts	124	2	....	2
Physics and E. E	7w	Principles of E. E	129	3	....	3
Physics and E. E	8w	Dynamo Laboratory	130	....	3	1½
		Electives	....	....	....	11½

Compressed Air, Internal Combustion, Engines, Heating and Ventilating, Refrigeration, Ore Dressing, Alloys, and Metallography, and Engineering Writing may be chosen as electives.

VI. ELECTRICAL ENGINEERING CURRICULUM.

The Freshman Year is the same as in I.

Department.	No.	Course.	Page.	Hrs. per week. Lect.	Lab.	Hours credit.
SOPHOMORE YEAR.						
FIRST SEMESTER.						
Civil Engineering	2f	Plane Surveying	68	....	6	3
English	3f	English Prose	76	3	....	3
Mathematics	9f	Differential Calculus	90			
Mathematics	11f	Integral Calculus	90	4	....	4
Mechanical Engineering	4f	Machine Drawing	98	....	3	1½
Mechanical Engineering	16f	Foundry	101	....	3	1½
Physics	1f	General Physics	128	3	....	3
Physics	2f	Physics Laboratory	128	....	3	1½
		Elective	....	....	....	3
Military Drill	......	......	118	....	3	0
SECOND SEMESTER.						
Chemistry	34w	Fuel Analysis	64	....	3	1½
English	3w	English Prose	77	2	....	2
Mathematics	11w	Integral Calculus	90			
Mathematics	13w	Differential Equations	90	4	....	4
Mechanics	17w	Mechanics	94	4	....	4
Mechanical Engineering	18w	Machine Shop	102	....	6	3
Physics	3w	General Physics	129	3	....	3
Physics	4w	Physics Laboratory	129	....	3	1½
		Elective	....	....	....	2
Military Drill	......	......	118	....	3	0

VI. ELECTRICAL ENGINEERING CURRICULUM—*Continued.*

Department.	No.	Course.	Page.	Hrs. per week. Lect.	Lab.	Hours credit.
JUNIOR YEAR.						
First Semester.						
Civil Engineering	9f	Hydraulics	70	3	3	4½
Mathematics	19f	Mechanics of Materials	94	4	....	4
Physics and E. E	7f	Principles of E. E	129	3	....	3
Physics and E. E	8f	Dynamo Laboratory	130	....	3	1½
Mechanical Engineering	3f	Mechanism	98	3	....	3
Mechanical Engineering	5f	Boilers and Engines	98	3	....	3
Mechanical Engineering	22f	Machine Design	103	....	3	1½
Second Semester.						
Civil Engineering	20w	Materials Laboratory	73	....	3	1½
Mechanical Engineering	6w	Steam Laboratory	98	....	3	1½
Mechanical Engineering	9w	Thermodynamics	100	3	....	3
Metallurgy and Ore Dressing	41w	Metallurgy of Iron and Steel	117	3	....	3
Physics and E. E	7w	Principles of E. E	129	3	....	3
Physics and E. E	8w	Dynamo Laboratory	130	....	3	1½
Physics and E. E	10w	Electrical Laboratory	130	....	6	3
		Electives	....	....	....	5
SENIOR YEAR.						
First Semester.						
Mechanical Engineering	9f	Power Plants	99	3	3	4½
Physics and E. E	11f	Electrical Machinery	130	2	3	3½
Physics and E. E	13f	Alternating Currents	131	5	....	....
		Electives	....	....	....	8
Second Semester.						
Civil Engineering	19w	Contracts	124	2	....	2
	11w	Electrical Machinery	130	2	3	3½
Physics and E. E	13w	Alternating Currents	131	5	....	5
Physics and E. E	19w	Electrical Distribution	131	3	....	3
		Electives	....	....	....	7½

Electric Railways, Electro-Metallurgy, Electro-Chemistry, Electrical Transmission and Power Engineering, Engineering Writing and advanced Modern Languages may be chosen as electives.

VII. CHEMICAL ENGINEERING CURRICULUM.

The Freshman year is the same as Curriculum I.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
SOPHOMORE YEAR.						
First Semester.						
*Chemistry	*21f	Organic Chemistry	61	*2	....	2
*Chemistry	*22f	*Organic Chemistry	61		*3	1½
Chemistry	31f	Analytical Chemistry	63	2	....	2
Chemistry	32f	Analytical Laboratory	63	....	9	4½
English	3f	English Prose	76	3	....	3
Mathematics	9f	Differential Calculus	90			
Mathematics	11f	Integral Calculus	90	4	....	4
Physics	1f	General Physics	128	3	....	3
Physics	2f	Physics Laboratory	128	....	3	1½
Military Drill	......	......	118	....	3	0
Second Semester.						
*Chemistry	*21w	Organic Chemistry	61	*2	....	2
*Chemistry	*22w	Organic Chemistry	61	....	*3	1½
Chemistry	32w	Quantitative Laboratory	64	....	8	4
English	3w	English Prose	77	2	....	2
Mathematics	11w	Integral Calculus	90			
Mathematics	13w	Differential Equations	90	4	....	4
Mechanics	17w	Mechanics	94	4	....	4
Physics	3w	General Physics	129	3	....	3
Physics	4w	Physics Laboratory	129	....	3	1½
Military Drill	......	......	118	....	3	0

*Students in Curriculum II, (see page 43) substitute Geology and Mineralogy 2f, 19f, 21w, 22w for Chemistry 21f, 22f, 21w, 22w.

VII. CHEMICAL ENGINEERING CURRICULUM.—*Continued.*

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit.
JUNIOR YEAR.						
First Semester.						
Chemistry	35f	Physical Chemistry	64	3	....	3
Chemistry	36f	Physical Chemistry	64	....	6	3
Chemistry	123f	Organic Chemistry	65	3	....	3
Chemistry	124f	Organic Chemistry	65	....	6	3
Geology and Mineralogy	2f	Mineralogy	....	....	3	1½
Geology and Mineralogy	19f	Engineering Geology	....	1	....	1
Mechanics	19f	Mechanics of Materials	94	4	....	4
Mechanical Engineering	5f	Boilers and Engines	98	3	....	3
Second Semester.						
Chemistry	17w	Industrial Chemistry	59	3	....	3
Chemistry	18w	Industrial Chemistry	60	....	6	3
Chemistry	23w	Industrial Economics	61	3	....	3
Chemistry	25w	Electrochemistry	62	2	....	2
Chemistry	26w	Electrochemistry	63	....	6	3
Mechanical Engineering	6w	Steam Laboratory	98	....	3	1½
Metallurgy and Ore Dressing	1w	Assaying	106	2	....	2
Metallurgy and Ore Dressing	2w	Assay Laboratory	107	....	3	1½
Metallurgy and Ore Dressing	39w	General Metallurgy	116	3	....	3

VII. CHEMICAL ENGINEERING CURRICULUM—*Continued.*

Senior Year.

Required Chemistry 17f, 18f.

Electives, 38 semester hours, should be chosen so that about half of the work is in the Departments of Chemistry and of Metallurgy, and the schedule must be approved by the Chemistry Department.

VIII. GRADUATE CURRICULUM IN MINE ENGINEERING.

Graduates of this or other institutions of equal rank who have received the degree of Bachelor of Science in Mine Engineering may matriculate for a course of graduate study and research in Mine Engineering. The minimum requirement is the completion of forty semester hours including a thesis.

Candidates for degrees must give half their time to work upon a major subject which must be in the Department of Mining Geology, or Metallurgy and Ore Dressing. At least one-fourth of the work must be done in one of the other departments noted above. The major and the minor subjects must be approved by the Faculty before the student enters upon the work. A suitable thesis subject must be approved.

IX. GRADUATE CURRICULUM IN METALLURGY.

Graduates of this school or of other institutions of equal rank who have completed a course of study leading to the degree of Bachelor of Science in Metallurgy may undertake advanced work leading to the degree of Metallurgical Engineer. The minimum requirement is forty semester hours including a thesis.

Candidates for the degree of Metallurgical Engineer must give half their time to work upon a major subject in the Department of Metallurgy and Ore Dressing. At least ten units work shall be upon a minor subject in another department. The major, the minor, and the thesis subjects must be approved by the Faculty.

NORWOOD HALL

CHEMISTRY BUILDING

CHEMISTRY

Professor Gottschalk, Assistant Professors Turner and Dunlap, Mr. Nichols, Mr. Krause, Mr. Weiser, Mr. Lane.

Equipment.

One entire building is devoted to chemistry. The main chemical lecture room occupies the entire south wing of the building. The laboratories for general chemistry, qualitative analysis, and organic chemistry on the first floor of the main building, accommodate together about one hundred sixty students. The quantitative laboratories on the second floor have desk room for seventy-five students working at one time. In the north wing is a smaller lecture room, as well as a capacious laboratory for advanced students.

Excellent ventilation is provided by a thirteen-horsepower motor and suction fan connected with individual hoods over each laboratory desk and with the long lines of fume chambers distributed throughout the building. Gas, water, and air blast are supplied conveniently, while a steam-heated still of five gallons an hour capacity furnishes ample distilled water.

The equipment includes twenty-four first-class analytical balances, sixty sets of good analytical weights, sixty sets of volumetric instruments with Bureau of Standards stamps, several complete sets of gas analysis apparatus, standard instruments for the physical and chemical testing of petroleum and its products, a liberal supply of platinum ware, and a good selection of precision instruments for physico-chemical and electro-chemical measurements.

The department has secured the co-operation of some of the chemical manufacturing concerns and is preparing for exhibition a Museum of Industrial Chemistry. Exhibits of the raw material and products illustrating the processes in many of the industries have already been received and are being arranged for display.

An Industrial Laboratory with adequate machinery and accessories is being installed in the north wing of the Chemical Building. The machines installed will include a multiple-effect evaporator, vacuum pan, steam kettles, mixing machines, filter presses, apparatus for distillation and rectification, grinding machinery, and the incidentals necessary for the preparation of commercial chemicals, soap, paints, wood products, acids, oils, etc.

With the proposed rearrangement of the building more space will be available for laboratory work in organic, physical, and electro-chemistry, as well as in the applied chemistry.

Courses.

1f. GENERAL CHEMISTRY. *Lectures.* (Dunlap)

This course is a comprehensive study of the general principles of chemistry and of the more important non-metals. The fundamental laws of chemistry are developed in logical order, special attention being given to their application in practical computations. Carefully designed lecture experiments are a feature of the course. The class is divided into several smaller sections for recitation and discussion of problems.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first semester, four hours per week. Credit four hours.

Text: McPherson and Henderson, *A Course in General Chemistry.*
Ashley, *Chemical Calculations.*

1w. GENERAL CHEMISTRY. *Lectures.* (Dunlap)

Continuation of course 1f; devoted to the chemistry of the metals, with special consideration of the reactions employed in analytical chemistry, in metallurgy, and in geology. The ionic theory, phase rule, and mass-law are introduced and applied at advantageous points in the lectures.

The course concludes with a series of lectures on elementary applied chemistry.

Prerequisites: Chemistry 1f and 2f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, second semester, three hours per week. Credit three hours.

Text: Same as in 1f.

2f and w. GENERAL CHEMISTRY. *Laboratory.*
(Dunlap, Nichols, Weiser)

The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

Prerequisite: Must be accompanied by Chemistry 1f and w.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, three hours per week. Credit one and a half hours per semester.

Text: *Mimeograph Notes.*

4f. QUALITATIVE ANALYSIS. *Laboratory.* (Turner)

The student is drilled in the practical separation and identification of ordinary mineral constituents, the examples for practice

consisting of solutions mixtures of salts, alloys, and ores. Wet methods are followed entirely with the exception of a few tests by means of the spectroscope.

Prerequisite: Chemistry 2w.

Required in I., II., and IV.

Sophomore year, first semester, six hours a week. Credit three hours.

Text: Stieglitz, *Qualitative Analysis.*
Manuscript Notes.

6f. QUANTITATIVE ANALYSIS. *Laboratory.* (Turner)

Technical methods for the determination of copper, lead, zinc, arsenic, antimony, sulphur, and coal analysis. Essential parts of the course are the speed tests, in which students are required to report correct results on a number of copper, zinc, and lead ores within a stated time.

Actual ores, analyzed by the instructing staff, are on hand in quantity, and the students are trained to attain the same degree of accuracy which obtains in smelter laboratories.

Prerequisite: Chemistry 6w.

Required in I., and II.

Junior year, first semester, six hours per week. Credit three hours.

Text: Low, *Ore Analysis.*

6w. QUANTITATIVE ANALYSIS. *Laboratory.*
(Turner, Krause, Weiser)

Before beginning actual quantitative analysis, the student is required to make a careful study of the balance and of the method of weighing. The rest of the time is given to exercises in simple gravimetric analysis, with some volumetric analysis, chiefly on analyzed mixtures, closing with a (technical) clay analysis.

Prerequisites: Chemistry 4w.

Required in I., and II.

Sophomore year, second semester, six hours per week. Credit three hours.

Text: Moody, *Quantitative Analysis.*

15f. ENGINEERING CHEMISTRY. *Lectures.*

There is nothing more essential to the practical engineer of today, no matter inwhich of the special branches he is working, than an intimate knowledge of the chemistry as well as the mechanics of materials. In this course are taken up in order the chemistry of fuels, industrial waters, lubricants, building materials, lime and cement, paving and wood preservation, paints and varnishes, and explosives.

One hour per week is devoted to reports by the students on topics of interest gleaned from the industrial journals.

Prerequisites: Chemistry 6f, and 6w.

Required in II.

First semester, three hours per week. Credit three hours.

Text: Benson, *Industrial Chemistry.*
Manuscript Notes.

17w. INDUSTRIAL CHEMISTRY. *Lectures.* (Turner)

This is essentially an advanced course in Applied Chemistry. As considerable time is spent in the course in General Chemistry in discussing its application in the industries, a certain elementary knowledge of the subject is presupposed.

No attempt is made to burden the student with the usual mass of detail concerning the various standard processes, although a certain amount of textbook work is required. The application of physico-chemical methods to the solution of practical industrial problems is considered of primary importance and receives the maximum amount of attention. The theories underlying the more typical industrial operations are taken up, some time being devoted to discussions on drying, evaporation, crystallization, filtration, heat-transfer, distillation, etc.

The specific industries studied are selected for the typical operations they involve rather than in an attempt to cover the entire field. The selections may be made from the following, and may vary from year to year. The Acid Industrials, Ammonia and Alkali, Fertilizers, Commercial Chemicals, Distillation of Coal and Wood, Soaps, Oil Industries, Sugar and Glucose, Paper, Industrial Alcohol, Laundering, Textiles and Dyeing, Leather, etc.

Required in VII.

Prerequisites: 123f.

This course must be accompanied by Chemistry 18w.

Junior year, second semester, three hours per week. Credit three hours.

Text: Rogers, *Industrial Chemistry.*
Kremann-Potts, *Applications of Physico-Chemical Theory.*
Manuscript Notes.
Reference.

17f. INDUSTRIAL CHEMISTRY. *Lectures.* (Turner)

A continuation of 17w, together with a consideration of the design, erection and equipment of chemical plants.

Required in VII.

Prerequisite: Chemistry 17w.

Senior year, first semester, two hours per week. Credit two hours, including the Chemical Part of the Senior Trip or its equivalent.

Text and Reference: Dyson and Clarkson, *Chemical Works, Their Design, Erection and Equipment.*
Manuscript Notes and Blue Prints.

18w. INDUSTRIAL CHEMISTRY. *Plant.* (Turner, Lane)

This course is designed to accompany the lectures in Industrial Chemistry and to give the student an opportunity to revise his pre-acquired knowledge to fit large-scale operations. It is purposed that the chemical engineers should at this point in their course be required to demonstrate their ability in putting to practical use in the works those principles of chemistry and mechanical and electrical engineering which they may have learned in the more or less preparatory courses.

A detailed description of the plant with all its machinery and accessories cannot be given as yet, since all of the equipment has not been definitely decided on. It is the intention, however, to equip this laboratory as completely as possible with most of the appliances necessary for medium-scale operations. The plant will be arranged to illustrate the methods used in commercial chemical works, and the actual working of each process will be in charge of a superintendent appointed from among the students. This man is to be solely responsible for the success or failure of the work under his direction, and each man in the course must occupy this position in turn. The other students are to be arranged into a working force suitable to the process in hand.

The actual manufacture of some of the materials studied in Chemistry 17w is to be carried out, special attention being paid to yields and cost of manufacture.

This course must be accompanied by Chemistry 17w.

Required in VII.

Junior year, second semester, six hours per week. Credit three hours.

Text: Rogers, *Laboratory Guide of Industrial Chemistry.*
Manuscript Notes and Blue Prints.
Reference Works.

18f. INDUSTRIAL CHEMISTRY. *Plant.* (Turner)

A continuation of 18w.

Prerequisite: Chemistry 18w.

This course must be accompanied by Chemistry 17f.

Senior year, first semester, six hours per week. Credit three hours.

Text and Reference: As above.

21f. ORGANIC CHEMISTRY. *Lectures.* (Dunlap)

The course is an introduction to the simple organic compounds. Special emphasis is placed on the structure and nomenclature of the aliphatic series.

Prerequisites: Chemistry 1w, 2w.

Required in VII.

Sophomore year, first semester, two hours per week. Credit two hours.

Text: Cohen, *Theoretical Organic Chemistry.*

21w. ORGANIC CHEMISTRY. *Lectures.* (Dunlap)

A continuation of 21w, extending the consideration to the aromatic compounds.

Prerequisites: Chemistry 21f.

Required in VII.

Sophomore year, second semester, two hours per week. Credit two hours.

Text: As above.

22f. ORGANIC CHEMISTRY. *Laboratory.* (Dunlap)

Preparation and purification of typical alphatic compounds, illustrating general methods of synthesis and technique of manipulations.

Prerequisites: Must be accompanied by Chemistry 21f.

Required in VII.

Sophomore year, first semester, three hours a week. Credit one and one-half hours.

Text: Cohen, *Practical Organic Chemistry.*

22w. ORGANIC CHEMISTRY. *Laboratory.* (Dunlap)

A continuation of 22f, illustrating important synthetic processes with typical aromatic compounds and introducing a study of the conditions of reactions.

Prerequisites: Accompanies Chemistry 21w.

Required in VII.

Sophomore year, second semester, three hours a week. Credit one and one-half hours.

Text: Cohen, *Practical Organic Chemistry.*

23w. INDUSTRIAL ECONOMICS. *Lectures.* (Gottschalk)

Before passing on to the consideration of the specific industries, which is taken up in the Senior year, the men are first introduced to some of the economic and administrative problems involved in chemical manufacturing. To begin with, this necessitates a rather extended reading course in Pure Political Economy, which is to

serve as a foundation for subsequent application to industrial problems.

While the student is acquiring this economic perspective, the subjects of Business Administration, which includes Accounting Systems, Purchasing, Selling, etc., Patents, Industrial Organization, Professional Ethics, Factory Hygiene and Scientific Management are discussed. The latter part of the course consists of lectures in and reading assignments on the following topics: Effect of Economic Conditions on Location of Chemical Plants, Price and Value of Products, Markets and Transportation, Labor, Legislation relating to the Use and Manufacture of Chemicals, Industrial Insurance, Competition, Exports and Imports and the Exploitation of Chemical Ideas.

During 1917-1918, the Registrar, Mr. Edw. Kahlbaum, gave the lectures on accounting, in this course.

Prerequisites: Chemistry 35f.

Required in VII.

Junior year, second semester, three hours per week. Credit three hours.

Text: Ely, *Outlines of Economics.*
Manuscript Notes.

24f. CHEMICAL ENGINEERING DATA. *Laboratory.* (Gottschalk)

To continue and supplement the work described in Chemistry 23w. To consist mainly of individual research in the collection and compilation of data concerning the administrative as well as the scientific side of Chemical Manufacturing. An attempt is made to gain some insight into the manner in which the office collects, files and interprets the facts and figures furnished by the works. Graphical methods of presentation of the information gathered are studied, and cost, efficiency and valuation curves constructed from data furnished by the industries.

Prerequisite: Chemistry 23w.

First semester, three hours per week. Credit one and one-half hours.

25w. ELECTRO-CHEMISTRY. *Lectures.* (Gottschalk)

A study of the theories of electrolysis, conductance of electrolytes, electromotive force, polarization.

Prerequisites: Chemistry 35f. Physics 4f.

Required in II., and VII.

Junior year, second semester, two hours a week. Credit two hours.

Text: LeBlanc, *Electro-chemistry.*

26w. ELECTRO-CHEMISTRY. *Laboratory.* (Gottschalk)

Measuements of conductivity, electromotive force, resistance single potentials; electro-deposition of metals, electro-analysis.

Prerequisites: Must be accompanied by Chemistry 25w.

Required in II., and VII.

Junior year, second semester, six hours a week. Credit three hours.

Texts: Findlay, *Practical Physical Chemistry.*
Watts, *Laboratory Course in Electro-chemistry.*

31f. ANALYTICAL CHEMISTRY. *Lectures.* (Turner)

This course is designed primarily for Chemical Engineers and those students specializing in Chemistry. The first twelve periods will be devoted to a discussion of Qualitative Analytical methods.

During the remainder of this course the following subjects will be discussed:—The balance, weights, and the process of weighing; simple gravimetric analysis; volumetric instruments, their calibration and use; volumetric analysis, standard solutions, and indicators.

Problems in the calculations of analytical chemistry are also discussed.

Prerequisites: Chemistry 2f and 2w. To be accompanied by Chemistry 32f.

Required in VII.

Sophomore year, first semester, two hours per week. Credit two hours.

Text: Stieglitz, *Qualitative Chemical Analysis.*
Manuscript Notes.

32f. ANALYTICAL CHEMISTRY. *Laboratory.*
(Turner, Krause)

The student will devote the first eighteen laboratory periods to the qualitative separation and detection of the metals.

The application of the principles of Quantitative Analysis as illustrated in the simpler Gravimetric and Volumetric determinations will then be taken up.

It is purposed in this course to lay a broad foundation of analytical principles upon which the student may build up by subsequent practice.

Prerequisites: To be accompanied by Chemistry 31f.

Required in VII.

Sophomore year, first semester, nine hours per week. Credit four and one-half hours.

Text: Blasdale, *Quantitative Analysis.*
Manuscript Notes.

32w. QUANTITATIVE ANALYSIS. *Laboratory.* (Turner)

This is a continuation of course 32f.

Prerequisites: Chemistry 31f and 32f.

Required in VII.

Sophomore year, second semester, eight hours per week. Credit four hours.

34w. FUEL AND GAS ANALYSIS. *Laboratory.* (Turner)

A more or less practical course in fuel and gas testing especially adapted to the needs of the Mechanical and Electrical Engineer.

Prerequisite: Chemistry 1w and 2w.

Required in V., and VI.

Sophomore year, second semester, three hours per week. Credit one and one-half hours.

Text: Gill, *Engine Room Chemistry.*

35f. PHYSICAL CHEMISTRY. *Lectures.* (Gottschalk)

While some attention is paid to the application of physical methods to chemistry, and the qualitative and quantitative theories of chemical equilibria as given by the phase rule and the mass law, the special stress in this course is laid on the study of the effects of the equilibrium factors on chemical reactions.

Prerequisites: Chemistry 6w or 32w. Physics 3w and 4w. To be accompanied by Chemistry 36f.

Required in II. and VII.

Junior year, first semester, three hours per week. Credit three hours.

Text: *Manuscript Notes.*

36f. PHYSICAL CHEMISTRY. *Laboratory.* (Gottschalk)

Laboratory to accompany Chemistry 35f.

Prerequisites: Same as 35f.

Required in II. and VII.

Junior year, first semester, six hours per week. Credit three hours.

Text: Findlay, *Practical Physical Chemistry.*

38. JUNIOR TRIP. At the end of the school year, the members of the Junior Class take a three weeks' trip to more distant chemical plants. Credit may also be obtained for this trip in the following manner: The student may obtain employment at some chemical plant of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompaned by a suitable report on the chemical industry of the district in which he is employed. Affidavit must be furnished by the student, signed by the proper

official of the chemical plant, stating the time of such employment and nature of work.

Credit will be given for this course only to candidates for the degree of B. S. in Chemical Engineering.

Prerequisites: 17b, 18b.

Junior year, Summer session. Credit six hours toward Senior elective in VII.

112w. WATER ANALYSIS. *Laboratory.* (Turner)

This course is designed to meet the wants of engineering students. Sanitary water analysis and boiler water analysis are offered, although students interested in geology may substitute mineral water analysis for some of the work.

Prerequisite: Chemistry 6f or 32f.

Elective, second semester, six hours per week. Credit three hours.

120f. ORGANIC ANALYSIS. *Laboratory.* (Turner)

A laboratory course in the analysis of commercial products.

Prerequisite: Chemistry 21w and 22w.

Elective six hours per week. Credit 3 hours.

122w. APPLIED ELECTRO-CHEMISTRY. *Laboratory.* (Gottschalk)

A laboratory course in the construction, testing and operation of primary and storage cells; preparation of inorganic and organic compounds by means of electrolysis; electroplating.

Prerequisites: 25w and 26w.

Elective six hours per week. Credit three hours.

123f. ADVANCED ORGANIC CHEMISTRY. *Lectures.* (Dunlap)

A general review of the whole field of the aliphatic and aromatic compounds, followed by an intensive study of some phase of industrial organic manufacture. Lectures, assigned reading, recitations, and reports on the manufacture of special organic products such as dyes, rubber, cellulose, sugars, etc.

Prerequisite: 21w.

Junior year, first semester three hours per week, credit three hours.

124f. ADVANCED ORGANIC CHEMISTRY. *Laboratory.* (Dunlap)

Advanced preparations followed by intensive study of some problems selected for the special needs and ability of the student.

Prerequisite: To be accompanied by 123f.

Junior year, first semester, six hours per week, credit three hours.

125w. GENERAL ORGANIC PROCESSES. *Lectures.*
(Dunlap)

Lectures, assigned readings, and reports on such processes as oxidation, reduction, sulfonation, esterification, etc.

Prerequisite: 123f.

Elective, second semester, two hours per week, credit two hours.

126w. SPECIAL ORGANIC LABORATORY. *Laboratory.*
(Dunlap)

Work to accompany 125w. Students are assigned special problems according to their training and fitness.

Prerequisite: To be accompanied by 125w.

Elective, second semester, six hours per week, credit three hours.

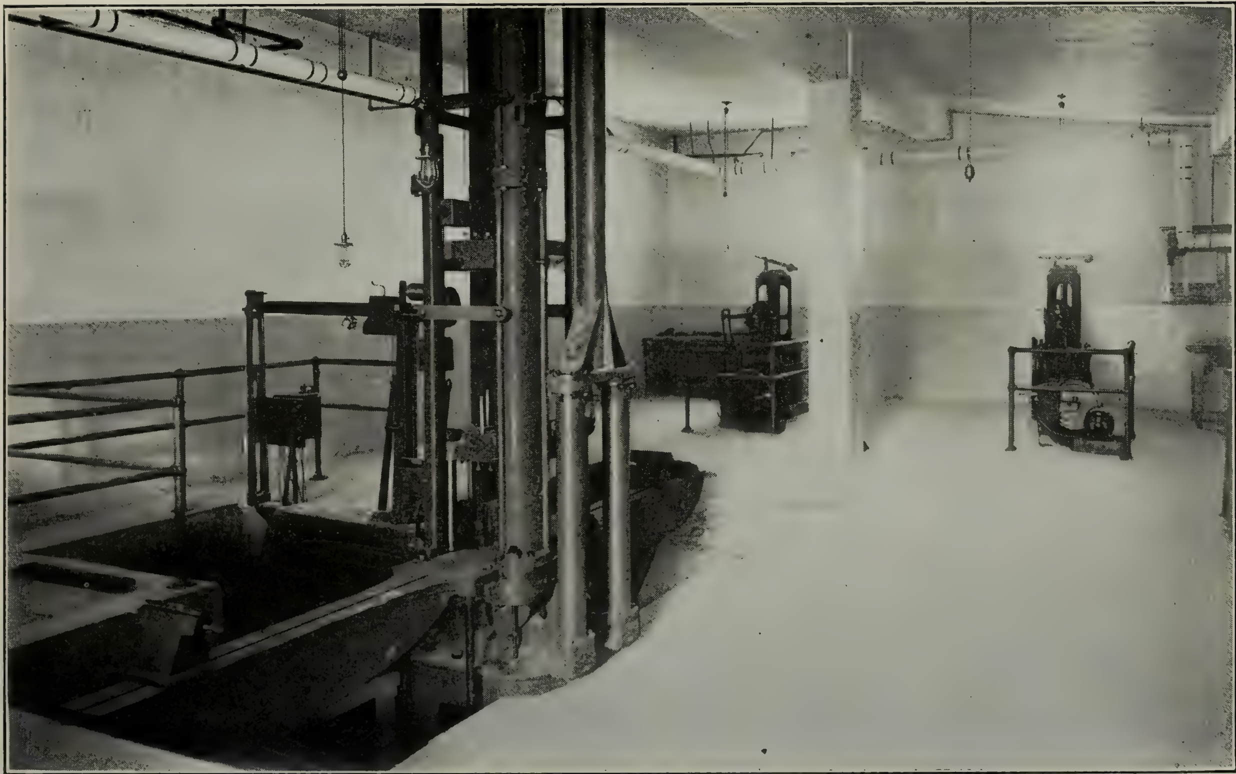
200, 202, 204 f and w. SENIOR PROBLEMS. *Laboratory.*
(Gottschalk, Turner, Dunlap)

For senior students who show special aptitude, a number of original problems are usually available. These problems require close attention to laboratory work, consistent search in the literature, and much home work in co-ordinating results, and should be elected only by students of a serious turn of mind who intend later to follow research in pure or applied chemistry as a specialty: for such men, this course serves as introductory to independent work.

Prerequisite: 125 hours credit in IV. or VII.

Elective, twelve hours per week, credit six hours.

CAMPUS VIEW



TESTING MACHINERY — MATERIALS LABORATORY

CIVIL ENGINEERING

Professor Harris, Assistant Professor McCandliss*, Assistant Professor Wallis, Mr. Armsby, Mr. Reber, Mr. Burkhart†.

The Department of Civil Engineering has its lecture rooms, drafting rooms, offices and department library in Norwood Hall. The hydraulics laboratory, and the locker rooms for field equipment, are in the Power Plant Building.

The Laboratory for Testing Materials and the Cement Testing Laboratory, together with office, supply and computation rooms, occupy almost the entire ground floor of Parker Hall.

The plan of study is designed to afford such training, that the graduates will be prepared to perform at once the minor duties in the various branches of the profession. Especial stress is laid upon proficiency in field work, drafting and the design of engineering structures.

For field work the department is equipped with twenty transits, five of which are complete mining instruments with side and top telescopes, and fifteen wye and dumpy levels, representing the principal makes and types of construction. Additional equipment includes a solar compass, a surveyor's compass, three geologist's compasses, four Brunten transits, thirteen plane tables, two sextants, and a liberal supply of hand levels, barometers, clinometers, dip-needles, angle prisms, chains, tapes, level rods, stadia rods, range poles, etc.

The field work is so outlined that the student has an opportunity to judge the relative merits of the various types of field instruments.

An important feature of the instrument room is the locker system. Due to the scope of the equipment it has been possible to arrange in separate lockers complete equipment for each surveying squad.

For the hydrographic field work the department is liberally equipped with current meters, gauges, floats, etc.

The hydrographic field is not outlined with the regularly catalogued courses but is given as a special course for Seniors in the School of Civil Engineering. The work is usually conducted on the Gasconade river.

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*On leave of absence.
†First semester.

The department has at its disposal three well equipped drafting rooms.

The laboratory for testing materials is equipped with one 200,000 pound capacity universal testing machine of the Olsen type, which is capable of testing specimens eight feet long in either tension or compression, and specimens in cross bending 16 ft. long between supports. It also contains two machines, each of 50,000 pound capacity, of the Riehle type, which are used for testing small specimens in tension, compression and cross-bending; one 60,000 inch-pound capacity torsion machine of the Olsen type, and one machine used for demonstration of the action of levers, and for testing small specimens in cross bendings. All machines in this laboratory are direct connected motor driven. The necessary small equipment, such as extensometers, compressometers, etc., is ample for the needs of the classes, and comprises only the most modern types of instruments.

This laboratory affords facilities for: Research in the design and the methods of failure of structures, the study of the physical characteristics and composition of materials, and the determination of the laws controlling the behavior of stressed and unstressed members.

The cement testing laboratory is equipped for making complete physical tests of cement, concrete and concrete aggregates, and for investigations of the proper proportioning of concrete. The equipment consists of two standard tension testing machines; two Vicat apparatus; several specific gravity apparatus; one electric drying oven; one standard steamer; an autoclave; a moist closet; apparatus for determination of specific gravity of, and voids in, concrete aggregate; several sets of standard sieves; standard cylindrical molds for concrete; and an ample supply of standard tension briquette molds, graduates, trowels, spatulas and other small apparatus.

Courses.

1f. PLANE SURVEYING. *Lectures.* (Armsby)

The theory of Plane Surveying, including the adjustments and uses of transits, levels, and the minor instruments; land surveying; traverses; levelling; determination of meridian; topographic surveying and mapping; and the usual computations used in connection with plane surveying.

Prerequisites: Mathematics 1f, 3f. To accompany Civil Engineering 4f.

Required in III.

Sophomore year, first semester, two lectures per week. Credit two hours.

4f. PLANE SURVEYING. *Laboratory.*
(Armsby, Reber, Burkhart)

A laboratory course to accompany Civil Engineering 1f. The problems discussed in the classroom are taken up in the field and drafting room, and the students are given thorough drills in each, to familiarize them with the usual field and office methods. During the winter a complete map of a portion of the town or campus is plotted from the notes taken in the field earlier in the term, thus helping to emphasize the practical nature of the work done, and also affording a check on the field work.

The simpler problems are conducted on and about the campus, the work being referenced to stations of a triangulation system, the bearings and lengths of sides of which have been accurately determined, thus affording a check on the student work.

Prerequisites: Mathematics 1f, 3f. To be accompanied by Civil Engineering 1f.

Required in III.

Sophomore year, first semester, three afternoons per week. Credit four and one-half hours.

2f. PLANE SURVEYING. *Laboratory.*
(Armsby, Reber, Burkhart)

An abridgement of courses 1f and 4f for students in courses other than Civil Engineering. Very much the same ground is covered, but the work is necessarily abbreviated in scope, and slightly modified to better suit the needs of the student taking the work.

Prerequisites: Mathematics 1f, 3f.

Required in I., V., and VI. This course cannot be substituted for Civil Engineering 1f and 4f.

Sophomore year, first semester, two afternoons per week. Credit three hours.

4w. ADVANCED SURVEYING. *Laboratory.*
(Armsby, Reber)

A continuation of the work given in Civil Engineering 4f, with the addition of some of the simpler astronomical observations, base line measurement, triangulation, stadia and plane table work, road traversing, and other problems. A complete topographical map of a small area is made.

Prerequisites: Civil Engineering 1f and 4f.

Required in III.

Sophomore year, second semester, two afternoons per week. Credit three hours.

6w. CIVIL ENGINEERING DRAWING. *Laboratory.* (Wallis)

This course is designed to represent the conditions of office and drafting room. Especial stress is laid on neatness, accuracy, and dispatch. The course covers practice in freehand lettering for titles, maps, etc., topographical signs, drafting conventions, and the drawing of simple engineering structures.

Prerequisites: Civil Engineering 1f and 4f, Mechanical Engineering 2w.

Required in III.

Sophomore year, second semester, one afternoon per week. Credit one and one-half hours.

7f. RAILROAD SURVEYING. *Lectures and Laboratory.* (Wallis)

This course treats of the theory and practice of surveying pertaining to the location, construction and maintenance of railroads.

The course is designed to acquaint the student with the theory of simple, compound, and reversed curves; frogs; switches; turnouts; crossovers; and earthwork computations. The afternoon period is devoted to field and office problems.

Prerequisites: Civil Engineering 1f and 4f or 2f.

Required in I. and III.

Junior year, first semester, one lecture and one afternoon per week.

Credit two and one-half hours.

8f. RAILROAD SURVEYING. *Laboratory.* (Wallis)

Field and office practice. A short line of railroad is projected and located in the field, the object of the work being to acquaint the student with the details and sequence of each engineering operation included in the general problem of railroad location.

Prerequisite: Must be accompanied by Civil Engineering 7f.

Required in III.

Junior year, first semester, one afternoon per week. Credit one and one-half hours.

7w. RAILROAD SURVEYING. *Lectures and Laboratory.* (Wallis)

This course is intended to extend the scope of Civil Engineering 7f, and treats of the theory of spirals, earthwork, haul, overhaul, and estimates.

Prerequisite: Civil Engineering 7f.

Required in III.

Junior year, second semester, one lecture and one afternoon per week.

Credit two and one-half hours.

9f. HYDRAULICS. *Lectures and Laboratory.* (Harris)

The theory of hydrostatics and of hydraulics, and its application to the dependent problems in engineering practice; determination of empirical coefficients and their application in determining the flow of water through orifices, weirs, pipes, canals, and rivers.

Prerequisites: Mathematics 15f.

Required in I., II., and III.

Junior year, first semester, three lectures and one afternoon per week. Credit four and one-half hours.

11f. MASONRY CONSTRUCTION. *Lectures.* (Armsby)

The object of this course is to study the fundamental principles underlying the selection, testing, preparation, and use of the various building materials in masonry structures. The treatment of ordinary and pile foundations, foundations under water, dams, retaining walls, piers, abutments, and culverts are successively taken up and studied.

Prerequisites: Mathematics 15f. To be accompanied by Mathematics 19f.

Required in III.

Junior year, first semester, three lectures per week. Credit three hours.

11w. REINFORCED CONCRETE. *Lectures and Laboratory.* (Harris)

This course covers the theory and design of concrete-steel beams, slabs, tanks, dams, culverts, conduits, retaining walls, and columns.

Prerequisites: Mathematics 19f and Civil Engineering 11f.

Required in III.

Junior year, second semester, two lectures and one afternoon per week. Credit three and one-half hours.

13w. ROADS AND PAVEMENTS. *Lectures.* (Armsby)

This course treats of the economic properties of road materials; the location, construction and maintenance of roads and streets; types of improvements, their designs and estimates of cost.

A special feature of this course is the seminar work, which is conducted one hour each week. Throughout the year each member of the class is required to prepare and present to the class papers on some assigned subject relative to roads and pavements.

Prerequisites: Civil Engineering 1f, 4f, and 11f.

Required in III.

Junior year, second semester, three lectures per week. Credit three hours.

15w. STRESSES. *Lectures and Laboratory.* (Harris)

This course covers the graphic and analytic determination of stresses in the simpler engineering structures under their various loads, including derricks, roof trusses, and single span bridges.

Prerequisites: Mathematics 17w, 19f.

Required in III.

Junior year, second semester, two lectures and two afternoons per week. Credit five hours.

15f. FRAMED STRUCTURES. *Lectures and Laboratory.* (Harris)

This course is a continuation of Civil Engineering 15w and covers the complete design, with estimates and bills of materials of plate girders, bridges, roofs, towers, steel building frames, and the like.

Prerequisites. Civil Engineering 15w.

Required in III.

Senior year, first semester, three lectures and two afternoons per week. Credit six hours.

17w. CONTRACTS. *Lectures.* (Harris)

A lecture course in the law of contracts, and the preparation of specifications.

Prerequisites: Completion of the Junior course.

Required in III.

Senior year, second semester, two lectures per week. Credit two hours.

19f. WATER SUPPLY. *Lectures.* (Wallis)

This course covers the selection, storing, transporting, purification, and delivering of water to cities and towns.

Prerequisites: Civil Engineering 9f, and 11w.

Required in III.

Senior year, first semester, three lectures per week. Credit three hours.

20f. MATERIALS TESTING LABORATORIES. *Laboratory.* (Armsby, Burkhart)

In this course the student's time is divided between the cement testing laboratory and the laboratory for testing materials. Early

in the semester the work consists of making complete physical tests of standard brands of natural and Portland cements, and the effects of such adulterants as free lime, sulphur acids and alkalies upon the strength and durability of the same. The laws governing the proportionment of concretes, and mortars, are verified experimentally.

Tests are conducted to show the relationship of strength to density in mortars and concrete; the effect of fineness of grinding of a cement on its setting properties; the effect of clay upon the strength and density of concrete; the effect of commercial waterproofing ingredients upon the porosity of concrete, and such other determinations as are appropriate to a laboratory of this character. The entire course is designed to impress the student with economic truths, the adaptability and the limitations of the use of mortars and concretes for materials of engineering construction.

The latter part of the semester is devoted to the physical tests in tension, compression, flexure and torsion of such materials as iron, steel, timber, stone, brick and other clay products; the study of the behavior of these materials under stress and the interpretation of the results of the investigations.

Prerequisite: Mathematics 15f.

Required in III.

Junior year, first semester, two afternoons per week. Credit three hours.

20w. MATERIALS TESTING LABORATORIES. *Laboratory.*

(Armsby, Reber)

The character of the work done in this course is essentially the same as that of Engineering Laboratories 20f, except that only one-half as much time is devoted to the work, necessitating fewer experiments and a more limited scope.

The major portion of the time is taken up with the physical tests of iron, steel, and timber, in tension, compression, cross-bending, and torsion; the study of the behavior of these materials when subjected to stress; the interpretation of the results of the tests, and the reports upon the same.

The work in the cement testing laboratory consists of a few exercises in the physical testing of natural and portland cements. (This course is not to be substituted for Engineering Laboratory 20f.)

Prerequisite: Mathematics 15f.

Required in I., V., and VI.

Junior year, second semester, one afternoon per week. Credit one and one-half hours.

21f. IRRIGATION AND DRAINAGE ENGINEERING. *Lectures.* (Harris)

The time here allotted is given to the study of special problems arising in the design of irrigation projects, such as location of the main canal and its head works, mapping the lands, locating the secondary canals, special methods of measuring and delivering the water, necessary water consumption, etc., and to the study of the cause and control of foods, protection of river banks, improvements of navigation, and protection and improvement of harbors.

Prerequisites: Civil Engineering 9f and 11w.

Elective.

Senior year, first semester, three lectures per week. Credit three hours.

23f. RAILROAD ECONOMICS. *Lectures.* (Wallis)

This course treats of the economic principles of the locations, revision, operation, and financing of railroads. The scope of the work covers train resistances under varying conditions of traffic, grade and curvature; locomotive performance; valuation of railroad properties; grade separation, etc.

Prerequisites: Civil Engineering 7f and 8f. To accompany Civil Engineering 7w.

Required in III.

Junior year, second semester, two lectures per week. Credit two hours.

29w. SANITARY ENGINEERING. *Lectures.* (Wallis)

Treats of the precautions necessary to protect water supplies from pollution and the methods available for the purification of sewage; also the construction of sewer systems for the collection and transportation of sewage and storm water.

Prerequisites: Civil Engineering 19f.

Required in III.

Senior year, second semester, three lectures per week. Credit three hours.

31f. MASONRY DESIGN. *Lectures and Laboratory.* (Harris)

This course is a logical continuation of Civil Engineering 11w. It includes the analysis and design of high masonry dams, reinforced concrete dams, long span arches, stacks, and the like. A portion of the time is given to tunneling and difficult foundations.

Prerequisites: Civil Engineering 11w.

Required in III.

Senior year, first semester, three lectures and two afternoons per week. Credit six hours.

32w. DESIGNING. *Laboratory.* (Harris)

The work in this course is selected to accord with the line of work in which the student expects or desires to specialize. He is required to find his material in the library, and to inform himself as to the best current practice relative to the problem assigned. Throughout this semester the student is required to keep informed as to the current Civil Engineering literature.

Prerequisites: Civil Engineering 15f and 31f.

Required in III.

Senior year, second semester, three afternoons per week. Credit four and one-half hours.

33w. MUNICIPAL ECONOMICS. *Lectures.* (Wallis)

This course covers in a broad way the principles of municipal economics and management.

Prerequisites: Civil Engineering 7w, 19f, 31f.

Required in III.

Senior year, second semester, three lectures per week. Credit three hours.

35f. CITY PLANNING. *Lectures.* (Wallis)

In this course the various phases of city planning are considered in a broad way and from a distinctly engineering standpoint.

Following a brief review of the history of city planning, the following topics are treated as fully as the time permits: the city planning movement; the street system, including the arrangement and width of traffic and of residential or minor streets; street traffic problems and regulation; street details; urban transportation systems; railroads in relation to the street system; housing in relation to city planning; public regulation of private property, including regulation of outdoor advertising, districting for uses and heights of buildings, and methods of taking land for public purposes; industrial districts; residential and industrial decentralization; industrial and satellite cities; land subdivision; municipal land policies; public buildings and civic centers; park systems and recreational facilities; city planning legislation, etc.

Prerequisites:

Elective.

Senior year, first semester, two lectures per week. Credit two hours.

37w. LANDSCAPE ENGINEERING. *Lectures and Laboratory.* (Wallis)

The lectures of this course treat briefly the principles of landscape design from the standpoint of the civil or the landscape engineer.

The application of these principles is brought out by designing problems which are worked out in the drafting room.

Prerequisites: Civil Engineering 6w and 13w and Mechanical Engineering 2w.

Elective.

Senior year, second semester, one lecture and one afternoon per week. Credit two and one-half hours.

ENGLISH AND MODERN FOREIGN LANGUAGES

Professor Barley, Assistant Professor Daniels, Mr. Hutsinpillar.

Mr. Stubbs, Assistant.

ENGLISH.

1f. RHETORIC AND COMPOSITION. *Lectures.* (Hutsinpillar)

A study of the theory of exposition, with especial attention to the paragraph and to the correct and the effective sentence. A reasonable amount of written work is required of the student in order that he may gain facility in the use of clear, idiomatic English. In many instances this written work is drawn from other courses pursued by the student, thereby correlating his practice in composition with his immediate interests and activities. There is also given weekly practice in oral composition.

Prerequisites: College entrance requirements in English.

Required in all courses.

Freshman year, first semester, three hours a week. Credit three hours.

Text: Linn, *Essentials of English Composition.*

1w. RHETORIC AND COMPOSITION. *Lectures.* (Hutsinpillar)

This course is a continuation of 1f. Attention is given to the theory of punctuation and to the writing of long themes. Some outside reading is required.

Prerequisite: 1f.

Required in all courses.

Freshman year, second semester, three hours a week. Credit three hours.

Text: Wooley, *Mechanics of Writing.*

3f. THE SHORT STORY. *Lectures.* (Barley)

An extended reading course in selected short stories, together with a critical study of representative specimens of this literary type.

Prerequisites: English 1f and 1w.

Sophomore year, first semester, three hours a week. Credit three hours.

3w. THE NOVEL. *Lectures.* (Barley)

A reading course in representative English and American novels of the nineteenth century and of the present day.

Prerequisites: English 1f and 1w.

Sophomore year, second semester, two hours a week. Credit two hours.

23f. MASTERPIECES. *Lectures.* (Barley)

Critical study of selected literary masterpieces.

Prerequisites: English 1f and 1w.

Sophomore year, first semester, three hours a week. Credit three hours.

23w. AMERICAN LITERATURE. *Lectures.* (Barley)

An advanced course in the history and development of literature in this country, with particular reference to the period following the Civil War.

Prerequisites: English 1f and 1w.

Sophomore year, second semester, two hours a week. Credit two hours.

Either 3f or 23f and either 3w or 23w are required of Sophomores in all courses.

5f. SHAKESPEARE. *Lectures.* (Barley)

Five or six of Shakespeare's plays are carefully studied in class and several more are required as collateral reading.

Prerequisites: Sophomore requirements in English.

Required in Curriculum IV.

Junior year, first semester, three hours a week. Credit three hours.

5w. CONTEMPORARY DRAMA. *Lectures.* (Barley)

A reading course in the drama of the present day, supplemented by lectures.

Prerequisites: As in 5f.

Required in Curriculum IV.

Junior year, second semester, three hours a week. Credit three hours.

19f. ENGINEERING WRITING. *Lectures.* (Barley)

An advanced course in oral and written technical reports and in the details and problems of engineering writing.

Senior year, first semester, two hours a week. Elective. Credit two hours.

MODERN FOREIGN LANGUAGES.

Students in Curriculum I are required to complete one year's work in German, or French, or Spanish, and those having completed Elementary Spanish may elect a second year's work in this language; those in Curricula II, V, VI and VII must complete one year's work in German, or French, or Spanish, and may elect an additional year's work in the language already pursued; those in Curricula III must complete two years' work in German, or French, or Spanish; those in Curricula IV must complete two years' work in German or French.

No advanced standing will be given for high school credits in language except by examination.

At present the United States Geological Survey requires French or German in its civil service examinations. Students who expect to qualify for this work are advised to elect one or both of these languages.

Students who expect to engage in work in Central America or South America are advised to elect Spanish.

7f. ELEMENTARY GERMAN. *Lectures.* (Hutsinpillar)

Open to all Freshmen.

Freshman year, first semester, three hours a week. Credit three hours.

Text: Thomas, *Practical German Grammar*, to be supplemented by easy reading as soon as practicable.

7w. ELEMENTARY GERMAN. *Lectures.* (Hutsinpillar)

Prerequisites: German 7f.

Freshman year, second semester, three hours a week. Credit three hours.

Texts: Thomas, *Practical German Grammar.*
Thomas and Hervey, *German Reader.*

9f. SCIENTIFIC GERMAN. *Lectures.* (Daniels)

Prerequisites: German 7f and 7w.

Sophomore year, first semester, three hours a week. Credit three hours.

Text: Kip, *Scientific German Reader.*

9w. RESEARCH GERMAN. *Lectures.* (Daniels)

Prerequisites: German 9f.

Sophomore year, second semester, two hours a week. Credit two hours.

Texts: Assigned articles in scientific textbooks and periodicals.

11f. ELEMENTARY FRENCH. *Lectures.* (Daniels)

Open to all Freshmen.

Freshman year, first semester, three hours a week. Credit three hours.

Text: Fraser and Squair, *French Grammar*, to be supplemented by easy reading as soon as practicable.

11w. ELEMENTARY FRENCH. *Lectures.* (Daniels)

Prerequisite: French 11f.

Freshman year, second semester, three hours a week. Credit three hours.

Texts: Fraser and Squair, *French Grammar.*
Easy stories and plays.

13f. SCIENTIFIC FRENCH. *Lectures.* (Daniels)

Prerequisites: French 11f and 11w.

Sophomore year, first semester, three hours a week. Credit three hours.

Text: Daniels, *French Scientific Reader.*

13w. RESEARCH FRENCH. *Lectures.* (Daniels)

Prerequisites: French 13f.

Sophomore year, second semester, two hours a week. Credit two hours.

Texts: Assigned articles in scientific textbooks and periodicals.

15f. ELEMENTARY SPANISH. *Lectures.* (Daniels)

Open to all Freshmen except those in Curricula IV.

Freshman year, first semester, three hours a week. Credit three hours.

Text: Hills and Ford, *Spanish Grammar.*

15w. ELEMENTARY SPANISH. *Lectures.* (Daniels)

Prerequisites: Spanish 15f.

Freshman year, second semester, three hours a week. Credit three hours.

Texts: Hills and Ford, *Spanish Grammar.*
Harrison, *Spanish Commercial Reader.*

17f. COMMERCIAL SPANISH. *Lectures.* (Daniels)

Prerequisites: Spanish 15f and 15w.

Sophomore year, first semester, three hours a week. Credit three hours.

Text: Ernesto Nelson, *The Spanish American Reader.*

17w. CONVERSATIONAL SPANISH. *Lectures.* (Daniels)

Prerequisites: Spanish 17f.

Sophomore year, second semester, two hours a week. Credit two hours.

Texts: Ernesto Nelson, *The Spanish American Reader.*
Hall, *All Spanish Method, First Book.*

GEOLOGY AND MINERALOGY

PROFESSOR COX, ASSISTANT PROFESSOR DAKE*, ASSISTANT PROFESSOR MUILENBURG, MR. CLARK, MR. SHANFELD, MR. ZOLLER.

Equipment.

The geological and mineralogical laboratories are on the second floor of Norwood Hall. They are supplied with suitable tables for the examination of rocks and minerals. The equipment of the department includes reference, working, and cabinet collections of minerals, ores, rocks, and fossils and many specimens illustrating metallurgical processes; a working collection of wooden and glass crystal models and natural crystals; full sets of maps and reports and a set of geological relief models.

There is also a collection of thirty-five hundred specimens representing the mineral wealth of Missouri, consisting of coal clays of many sorts, building stones, and ores of lead, zinc, iron, and copper. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. There is also a complete collection of the economic minerals of Missouri and a good economic geological collection representing the world at large. This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago and was presented to the School of Mines and Metallurgy by the General Assembly in 1895.

In addition to the above-mentioned collection the State Board of Equalization assigned to the School the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the School a large amount of valuable equipment.

The Museums contain crystals and minerals from various parts of the world, the important mining districts of the State of Missouri being especially well represented by the economic collection from Southwestern Missouri, the great geological relief map, polished stone tables and ornamental stones, and other complete collections of the Missouri Building of the St. Louis Exposition.

Rock-breaking and section machines, instruments for geological surveys, petrographic microscopes, thin mineral and rock sections, and lantern slides are included in the equipment of this department.

*On leave of absence, 1917-18.

1f. MINERALOGY. *Lectures and Laboratory.*
(Muilenburg, Clark and Shanfeld)

Elementary crystallography, including the study of models and natural crystals, with oral and written recitations, eleven weeks; practice in blowpipe analysis with determination of unknowns, four weeks; introduction to descriptive and determinative mineralogy the remainder of the semester.

Prerequisites: Chemistry 1w, 3w and 4w.

Required in I., II. and IV.

Sophomore year, first semester, one lecture and three hours of laboratory work per week. Credit two and one-half hours.

Texts: Patton, *Lecture Notes on Crystallography.*
Butler, *Handbook of Blowpipe Analysis.*
Dana, *Textbook of Mineralogy.*

1w. MINERALOGY. *Lectures and Laboratory.*
(Muilenburg, Clark)

Descriptive and determinative mineralogy. A study of the fundamental principles of classification and the distinctive characteristics of minerals with a thorough drill in the recognition of about two hundred species.

Prerequisite: Mineralogy 1f.

Required in I., II., also in IV. with geology major.

Sophomore year, second semester, one lecture and six hours of laboratory work per week. Credit four hours.

2f. GENERAL ENGINEERING MINERALOGY.
Lectures and Laboratory. (Muilenburg, Clark)

A study of the common ore and rock-forming minerals and types of rocks. The necessary lectures are given during the regular laboratory periods. This course is intended for the Civil, Mechanical, Electrical, and Chemical Engineering students, the same ground being covered more thoroughly by Courses 1f, 1b and 5w, so that full credit may not be given for it and one or more of these courses, and it may not be substituted for any part of them.

Prerequisite: Chemistry 1w.

Required in III. and VII.

Junior year, first semester, three hours per week. Credit one and one-half hours.

11f. OPTICAL MINERALOGY. (See Geology 11f.)

GEOLOGY.

Courses.

3f. GENERAL GEOLOGY. *Lectures.* (Muilenburg, Clark)

Dynamic geology. A somewhat detailed account of geologic processes. The larger topics are treated more exhaustively than in the required text. Local field trips.

Prerequisites: Either 2f or 1f and 1w.

Required in I. and in IV. with geology major.

Junior year, first semester, three hours per week. Credit three hours.

Text: Cleland, *Geology, Physical and Historical.*

3w. GENERAL GEOLOGY. *Lectures.* (Muilenburg, Clark)

Introductory structural and historical geology. Typical geologic structures and their effects upon the physiographic development of the earth's surface are considered for the first eight weeks. Geologic history is then traced from the beginning of the record to the present, as much attention as possible being paid to the rock systems and their contained fossils, with some reference to geographic changes and organic evolution.

Prerequisites: Geology 3f. To be accompanied by Geology 4w.

Required in I. and in IV. with geology major.

Junior year, second semester, three hours per week. Credit three hours.

Text: Cleland, *Geology, Physical and Historical.*

4w. GENERAL GEOLOGY. *Laboratory.*

(Muilenburg, Zoller)

Laboratory exercises in reading topographic and geologic maps; in the construction of profile and geologic sections and simple geologic maps. These exercises are designed to illustrate the subject-matter of the earlier lectures of Course 3w, and occupy nine weeks; excursions and field practice in elementary geologic mapping the remainder of the semester.

Prerequisite: Geology 3f. To accompany Geology 3w.

Required in I. and IV. with geology major.

Junior year, second semester, six hours per week. Credit three hours.

References: Hayes, *Handbook for Field Geologists.*
Geikie, *Outlines of Field Geology.*
Prof. Paper, *U. S. Geol. Survey No. 60.*

5w. LITHOLOGY. *Lectures and Laboratory.* (Cox, Zoller)

A study of the structure, texture, mineral and chemical composition, and the manner of formation and occurrences of igneous, sedimentary, and metamorphic rocks. This course is adequate for all general field determinations.

Prerequisites: Mineralogy 1f and 1w, to be accompanied by Geology 3w.

Required in I., and in IV. with geology major.

Junior year, second semester, one hour lecture and three hours of laboratory work per week. Credit two and one-half hours.

Text: Kemp, *Handbook of Rocks.*

7f. GEOLOGY OF THE UNITED STATES. *Lectures.*

The physiography, stratigraphy, economic products, and geologic structure and history of the chief geologic divisions of the United States are summarized in the lectures.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in IV. with geology major.

Senior year, first semester, three hours per week. Credit three hours.

Text: Blackwelder, *Handbook of Regional Geology: the United States.*

9f. ECONOMIC GEOLOGY. *Lectures.* (Cox)

A study of the origin, occurrence, and distribution of the metallic ores. Various type deposits of the world are considered, special attention being given to those of the United States. Written reports are required for each district studied; reference always being made to the original reports, thus familiarizing the student with the various technical publications and their usage. The ores of the following metals are considered: zinc, lead, copper, gold, silver, nickel, cobalt, iron, manganese, tin, mercury, tungsten, platinum, and aluminum. Trips to local points of interest.

Candidates for the degree of Bachelor of Science in Mine Engineering or Metallurgy taking this course must also take the geology part of Course 12, Senior Trip.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with general mining or geology options, and in IV. with geology major.

Senior year, first semester, four hours per week. Credit four hours.

Text: No text required. Reference largely to reports by the United States and State geological surveys.

9w. ECONOMIC GEOLOGY. *Lectures.* (Cox)

A study of the origin, occurrence, and distribution of the economic deposits of the non-metals. Reference is made to those technical reports which describe the most important deposits, and a written summary is required for each district studied. The subjects covered are as follows: coal, oil and gas, clays, cements gypsum, salt, sulphur, sulphides, building stone, abrasives, gems soils, and fertilizers. Trips to local points of interest.

Students taking this course who do not take Course 12 will be given special work while the remainder of the class is taking the Senior Trip.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with Geology option, and in IV. with Geology major.

Senior year, second semester, three hours per week. Credit three hours.

Text: No text required. Reference largely to reports of the United States and State geological surveys.

11f. PETROGRAPHY. *Lectures and Laboratory.* (Cox)

The semester is devoted to the study of optics as applied to the determination of minerals by the polarizing microscope, the identification of minerals in thin sections, and the grinding of rock and mineral thin sections.

Prerequisites: Geology 3w, 4w, and 5w, and Physics 3w and 4w.

Senior year, first semester, three lectures and nine hours of laboratory work per week. Credit seven and one-half hours.

Text: Luquer, *Minerals in Rock Sections.*

11w. PETROGRAPHY. *Lectures and Laboratory.* (Cox)

A study of nomenclature, relations and alterations of rocks together with the petrographic analysis and the recalculation of the chemical analysis of rocks.

Prerequisite: Geology 11f.

Senior year, second semester, three lectures and six hours of laboratory work per week. Credit six hours.

Texts: Kemp, *Handbook of Rocks*, with one of the following:
Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannson, *Determination of Rock-Forming Minerals.*

12. SENIOR TRIP. (Cox)

During the second semester of the Senior year a three weeks' trip is taken to Joplin, St. Louis, Flat River, and other points in the Southeastern Missouri Lead District, for the purpose of study-

ing Mining, Ore Dressing, Smelting, Geology, and Power Plants of these districts. The geology portion of these trips is required of all candidates for the degrees in Mining Engineering and Metallurgy who have taken Course 9f.

Prerequisite: Geology 9f.

Senior year, second semester.

13w. STRUCTURAL GEOLOGY. *Lectures.* (Cox)

An advanced course in the study of rock deformation, including a review of the theories of the origin of the earth; a discussion of the zones of rock fracture and rock flowage; a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates, and pseudo-conglomerates; and a consideration of mountain-building forces, together with the horizontal and vertical depth affected, with application to special districts.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with geology option and in IV. with geology major.

Senior year, second semester, three hours per week. Credit three hours.

14f. FIELD GEOLOGY. *Field Work.* (Cox)

The course consists of both field and laboratory work, the two being varied to suit the weather. The field work consists of the making of topographic and geologic maps, with suitable sections and reports, of assigned areas. The laboratory work includes the making of sections and maps and the final drafting of the field work.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with geology option and in IV. with geology major.

Senior year, first semester, six hours per week. Credit three hours.

15w. GEOLOGY CONFERENCE. (Cox)

The conference consists of a discussion by the students and instructors of geologic problems and literature, each student being assigned certain work upon which he must report to the class.

Prerequisite: Geology 9f.

Senior year, second semester, one hour per week. Credit one hour.

16w. ADVANCED GEOLOGY. *Laboratory.*

An advanced course in the study and interpretation of topographic and geologic maps.

Prerequisites: Geology 3w and 4w.

Required in IV. with geology major.

Senior year, second semester, nine lectures and ninety hours laboratory work for the semester. Credit three hours.

17f. OIL AND GAS. *Lectures.* (Cox)

A detailed study of the origin and occurrence of the various oil and gas deposits.

Prerequisites: Mineralogy 1w or 2f and Geology 3w.

Senior year, first semester, one hour a week. Credit one hour

17w. OIL AND GAS. *Lectures.* (Cox)

Field methods in petroleum geology.

Prerequisite: Geology 17f.

Senior year, second semester, one hour a week. Credit one hour.

18w. OIL AND GAS. *Laboratory.* (Cox)

Laboratory work in connection with course 17w, and in the interpretation and preparation of maps.

Prerequisites: Must be accompanied by Geology 17w and 4w.

Senior year, second semester, three hours a week. Credit 1.5 hours.

19f. GENERAL ENGINEERING GEOLOGY. *Lectures.* (Muilenburg)

An introductory course in general geology adapted to the general needs of students in Civil, Mechanical, Electrical and Chemical Engineering. The work covers dynamical geology with such detail as is possible in the time allowed.

Prerequisites: To be accompanied by Mineralogy 2f or preceeded by Mineralogy 1w.

Required in III. and VII.

Junior year, first semester, one hour per week. Credit one hour.

Text: Ries and Watson, *Engineering Geology.*

Offered in 1918-19.

21w. GENERAL ENGINEERING GEOLOGY. *Lectures.* (Muilenburg)

An introductory course in structural and historical geology and in non-metallic economic geology adapted to the needs of students in Civil, Mechanical, Electrical, and Chemical Engineering.

Prerequisites: Either Geology 19f or 3f.

Required in III.

Junior year, second semester, two hours per week. Credit two hours.

Text: Ries and Watson, *Engineering Geology.*

Offered in 1918-19.

22w. GENERAL ENGINEERING GEOLOGY. *Laboratory.* (Muilenburg)

A review of the minerals and rocks studied in Mineralogy 2f, together with laboratory studies in topographic and geologic maps and profiles. Adapted to the needs of students in Civil, Mechanical, Electrical and Chemical Engineering.

Prerequisites: To be accompanied by Geology 21w.

Required in III.

Junior year, second semester, two afternoons per week. Credit three hours.

Offered in 1918-19.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior class make a three weeks' trip to Colorado and Utah, or other mining districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students to be signed by the mine or mill officials, by whom he was employed, stating the time of such employment and nature of the work.

Credit will be given for this course only to candidates for degrees of B. S. in Mining and Metallurgy.

Prerequisites: Mining 5w, Geology 3w and 4w, and Metallurgy 31w.

Junior year, Summer session. Credit (geology portion) 2 hours toward Senior electives in I. and II.

40. SPECIAL GEOLOGY.

Special studies in geology, hours and subjects to be arranged with each student.

MATHEMATICS

PRNFESSOR DEAN, MR. HINSCH

While the utility of mathematical study as a mental discipline is duly recognized, the ultimate intention of the student is kept in mind, and the matter and methods of the courses are adjusted, as nearly as possible, to meet the demands of subsequent studies and professional practice.

COURSES

1f. COLLEGE ALGEBRA. *Lectures.* (Hinsch)

Theory of limits, logarithms, progressions, binomial theorem, undetermined coefficients, series and solution of higher equations. Special attention is paid to graphical solutions and practical applications.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, three hours per week, first semester. Credit three hours.

Text: Hall and Knight, *College Algebra.*

3f. PLANE TRIGONOMETRY. *Lectures.* (Hinsch)

Solution of plane triangles, reduction and transformation of trigonometric expressions, solution of trigonometric equations.

Prerequisite: Mathematics 1a.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first semester, two hours per week. Credit two hours.

Text: Taylor and Puryear, *Trigonometry.*

5w. SPHERICAL TRIGONOMETRY. *Lectures.* (Hinsch)

Continuation of Mathematics 3f, taking up more difficult parts of analytical trigonometry, solution of spherical triangles, and simpler problems of spherical astronomy.

Prerequisite: Mathematics 3f.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second semester, two hours per week. Credit two hours.

Text: Taylor and Puryear, *Trigonometry.*

7w. ANALYTICAL GEOMETRY. *Lectures.* (Hinsch)

The object of this course is to familiarize the student with methods rather than with any particular set of curves. Special attention, however, is given to those forms of the equations of the conic sections which occur in technical literature.

Prerequisite: Mathematics 5w.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second semester, three hours per week. Credit three hours.

Text: Smith and Granville, *Elementary Analysis.*

9f. DIFFERENTIAL CALCULUS. *Lectures.* (Dean)

The student is thoroughly drilled in the derivation of formulae and the application of derivatives in the solution of problems in maxima and minima, in curve tracing, velocity, and acceleration, expansion of functions.

Prerequisite: Mathematics 7w.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first twelve weeks of first semester, four hours per week. Credit three hours.

Text: Granville, *Calculus.*
Notes by Professor.

11f, 11w. INTEGRAL CALCULUS. *Lectures.* (Dean)

The student is drilled in the integration of forms occurring in mechanics and physics, in evaluating areas, moments, moments of inertia, in finding centers of gravity, center of stress, and in the derivation and application of fundamental formulae of hydrostatics and hydraulics.

Prerequisite: Mathematics 9f.

Required in I., II., III., V., VI. and VII.

Sophomore year, five hours per week, after 9f, and first twelve weeks of second semester. Credit one hour on each semester.

Text: Granville, *Valculus.*
Notes by Professor.

13w. DIFFERENTIAL EQUATIONS. (Dean)

Integrable forms of the differential equations of mechanics and physics, applications of partial differentiation and partial integration, theory of attraction, dynamics of a particle, and thermodynamics of perfect gases.

Prerequisites: Mathematics 11a and 11b.

Required in I., II., III., V., VI. and VII.

Sophomore year, second semester, five hours per week after 11w. Credit three hours.

Text: Granville, *Valculus.*
Notes by Professor.

31f. THE THEORY OF STRUCTURES. *Lectures.* (Dean)

The purpose of this course is to present in a thorough and logical manner the fundamental theories upon which the design of all structures is based and to illustrate their application by numerous examples. No attempt is made to treat of the design of complete structures, but the design of the more important elements of which all structures are composed is fully considered. Senior elective, three lecture hours per week. Credit three hours.

Prerequisites: Mathematics 1f to 13w, and Mechanics 17w to 19f.

Text: Spofford, *The Theory of Structures*, Chapters I., II., III., IV., V., VI. and VII., supplemented by lectures and notes.

31w. THE THEORY OF STRUCTURES. *Lectures.* (Dean)

Continuation of 31f. Credit three hours.

Text: Spofford, *The Theory of Structures*, Chapters VIII.-XX., inclusive, supplemented by lectures and notes.

33f. APPLIED MECHANICS. *Lectures.* (Dean)

This course is intended to give that general knowledge of the mechanics of structures and machines which should accompany the detailed study of any special branch of engineering. It will include the following subjects:

Statics of Structures, Kinematics of Machines, Dynamics of Machines, Stiffness and Strength of Materials, Transmission and Conversion of Energy by Fluids.

Senior elective, three hours per week. Credit three hours.

Text: Cotterill, *Applied Mechanics*, supplemented by lectures and notes.

33w. APPLIED MECHANICS. *Lectures.* (Dean)

Continuation of 33f. Credit three hours.

35f. MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. *Lectures.* (Dean)

This course is intended only for students with special mathematical aptitude. Credit three hours.

Texts: Pidduck, *A Treatise on Electricity.*
Berg, *Electrical Engineering.*
Lyons, *Problems in Electrical Engineering.*
Pender, *Principles of Electrical Engineering.*

35w. MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. (Dean)

Continuation of 35f.

Whether the subject is treated from the standpoint of pure physics or that of electrical engineering depends on the choice of the students electing the course.

MECHANICS.

Associate Professor Garrett.

17w. MECHANICS. *Lectures.* (Garrett)

The first half of the semester is devoted to statics. It is the aim of the course to train the student in the application of fundamental principles to practical problems. The second half of the semester is given to kinematics and kinetics with technical applications.

Prerequisites: Mathematics 11f.

Required in I., II., III., V., VI. and VII.

Sophomore year, second semester, four hours per week. Credit four hours.

Text: Maurer, *Technical Mechanics.*

19f. MECHANICS OF MATERIALS. *Lectures.* (Garrett)

A general course in the mechanics of materials. As the subject is developed the student is given a thorough drill in the application of principles to simple problems of design and in the use of standard handbooks.

Prerequisite: Mechanics 17w.

Required in I., II., III., V., VI. and VII.

Junior year, first semester, four hours per week. Credit four hours.

Text: Houghton, *Mechanics of Materials.*
Notes by instructor.

21w. ADVANCED MECHANICS OF MATERIALS. *Lectures.* (Garrett)

This course begins with a more advanced study of certain parts of the work covered in Mechanics 19f and includes further a discussion of such subjects as combined stresses, inertia circle and ellipse, kern, beams of unsymmetrical section, curved beams, flat plates and thick cylinders.

Prerequisite: Mechanics 19f.

Elective, second semester, three hours per week. Credit three hours.

Offered in 1918-19.

23f. ADVANCED MECHANICS. *Lectures.* (Garrett)

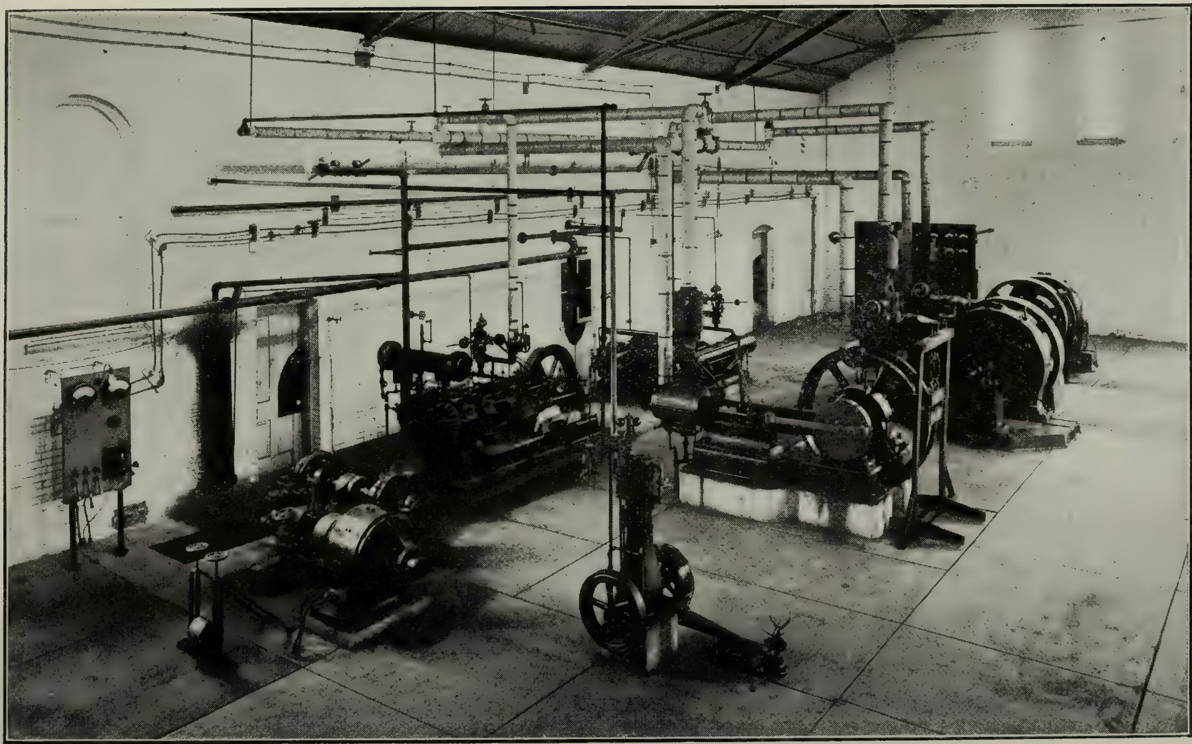
This course is designed primarily as a senior elective in curriculum V. or VI. While the subject-matter of the course is selected with reference to the needs of the class and may vary somewhat from year to year, it is for the most part along lines suggested by the following topics: Periodic Motion, Whirling Shafts and Rotating Discs, Vibration, Balancing.

Prerequisite: Mechanics 19f.

Elective, first semester, three hours per week. Credit three hours.

Not offered in 1918-19.

MECHANICAL HALL



STEAM LABORATORY

MECHANICAL ENGINEERING

Professor Dickerson, Assistant Professor Bowen,
Mr. Duffy*, Mr. Cole, Mr. Ashlock,
Mr. Davidson, Mr. Mellow.

The course for Juniors and Seniors in Mechanical Engineering are conducted in the lecture and drafting rooms in Norwood Hall, the experimental laboratories are located in the Power Plant Building and the drawing and shop practice are given in Mechanical Hall.

Equipment.

The power plant is used for experimental purposes, and comprises a modern equipped laboratory. The machinery available for testing purposes includes four 130-h. p. Heine safety boilers, especially equipped with openings in the setting for temperature and draft measurements in furnace, combustion chamber and flues; a 13 by 14 Erie Ball engine direct connected to a 75 kw. 220 volt D. C. Westinghouse generator; a 10 by 12 Ideal engine direct connected to a 50 kw. 220 volt D. C. Westinghouse generator; a 12 by 11 General Electric marine type engine direct connected to a 50 k. v. a. 220 volts, 60 cycle, three-phase generator with direct connected exciter; a 10 kw. 220 volt Curtis steam turbo generator; a six stage 36-h. p. Kerr steam turbine complete with prony brake on the same bed plate; a 9 by 14 Brownell engine equipped with a rope friction brake; a 5 by 7 Davis and Rankin vertical engine equipped with a Prony brake; a 21-h. p. Otto four strokes per cycle gas engine belted to a two-stage Worthington centrifugal pump; a 3-h. p. Ferro two strokes per cycle portable gas engine; a 8-h. p. K.-E. Bessemer gas engine equipped to run on either gasoline or crude oil; a 6H Continental automobile motor arranged for testing; a D. C. switchboard with a panel for each generator and two for distribution switches, equipped with a Tirrill voltage regulator, a Thompson recording watt-hour meter, circuit breakers for each generator, and the usual ammeters and voltmeter; an A. C. switchboard with voltmeter, ammeters, wattmeter, and watt-hour meter. The pneumatic equipment includes a Laidlow-Dunn-Gordon air compressor, a Rand Imperial air compressor, a Sullivan straight-line two-stage air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, a 60-inch Buffalo forge blower, an experi-

*On leave of absence, 1917-1918.

mental fan capable of delivering 250 cu. ft. of air per second at six inches of water pressure, two cylindrical steel tanks 6 ft. by 15 ft. for measuring air by water displacement.

The Ball and Ideal engines are equipped with a 20-in. shell Griscom-Russell surface condenser with a Blake vacuum pump.

The laboratory also contains a complete Wickes vertical boiler and engine ten horsepower plant fitted for testing purposes.

There is a complete steam and pumping plant at the experimental mine, where laboratory practice is also obtained.

The instrument room of the Mechanical Laboratory contains a good line of instruments used for testing purposes, some of which are listed below.

Parr and Roland-Wild coal calorimeters; Ellison throttling and evaporating moisture calorimeter; Peabody, and Schaeffer and Budenberg moisture calorimeters; General Electric Co., and Gebhart portable steam flow meters; Hays, and Orsat flue gas apparatus; Crosby, Thompson, Robertson, Schaeffer and Budenberg, and American steam and gas engine indicators; Schaeffer and Budenberg continuous drum indicator; Amsler, Crosby, Willis, and Keuffel and Esser planimeters; various indicating and recording steam gages; Crosby steam gage testers; Tycos portable pyrometer; cold and hot water meters; thermometers, manometers, tachometers and speed counters; and Prony friction brakes.

The shops are thoroughly equipped with machinery and benches adapted to instruction. The wood bench-work room contains twenty double benches with separate sets of hand tools. The lathe room is equipped with twenty Fay & Egan 12-in. swing college wood lathes and iron shears. The other machines in the lathe room include a Fay & Egan 27-in. planer, a Fay & Egan band saw with 30-in. wheels, Fay & Egan joiner, an Oliver universal saw-table, two Oliver wood trimmers, a mortise machine, jig saw, grindstones, and other necessary tools.

For instruction in forge work there are twenty-four Buffalo Forge Company down-draft forges, power hammer, drill press, power shears, and grinder.

The metal-working room contains:

One 20-in. by 8-ft. Reed Lathe.
One 12-in. by 6-ft. Reed Lathe.
One 14-in. by 6-ft. Hendey Lathe.
One 14-in. by 6-ft. American Lathe.
Four 13-in. by 5-ft. South Bend Lathes.
One No. 2A Brown & Sharpe Universal Milling Machine.
One No. 2 Universal Norton Grinder.
One Hendey 15-in. Pillar Shaper.
One Dwight Sensitive Drill
One Barnes 22-in. Swing Upright Drill Press.
One 24-in. Morse Double Emery Grinder.

One 24-in. by 24-in. by 6-ft. Chandler Planer.
Two Greenard Arbor Presses, No. $3\frac{1}{2}$ and No. 1.
One No. 1 Burr Cold Saw.
One 3-fire Chicago Flexible Shaft Gas Furnace.

All of the above-mentioned iron-working machinery is of latest design and driven by individual motors. The benches in the lathe room have hardwood tops mounted on standard Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work.

The drawing rooms are equipped with individual drawing tables and will accommodate two hundred and forty students working in two sections.

The blue print room contains a 42-in. x 60-in. Pease-Vertical electric blue printing machine and a sheet washer.

Courses.

1w. DESCRIPTIVE GEOMETRY. *Lectures and Laboratory.*
(Wallis, Ashlock, Davidson)

This course covers the fundamental principles of projective drawing with special reference to their application to engineering drawing.

Prerequisites: Mechanical Engineering 2f.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second semester, one lecture and one laboratory per week. Credit two and one-half hours.

2f. BEGINNING DRAWING. *Laboratory.*
(Wallis, Ashlock)

By means of a carefully graded series of exercises the student is drilled in the correct use of drafting instruments, especial emphasis being placed on the production of work of quality rather than of quantity. The student is required to master the standard style of single stroke lettering used on engineering drawings.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first semester, two (one 2 hr. and one 3 hr. period) laboratories per week. Credit two and one-half hours.

2w. ADVANCED DRAWING. *Laboratory.*
(Wallis, Ashlock)

This course is a continuation of Mechanical Engineering 2f and includes work in isometric, oblique and perspective projection as well as a careful drill in freehand sketching of machine parts in orthographic and perspective projection.

Prerequisites: Mechanical Engineering 2f.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second semester, one laboratory per week. Credit one and one-half hours.

3f. MECHANISM. *Lectures.* (Dickerson)

In this course are studied the principles which underly the action of the elementary combinations of which all machines are composed, also the motions and velocities of linkages, cams, and gears.

Prerequisites: Mechanical Engineering 4f and 18w.

Required in V. and VI.

Junior year, first semester, three hours per week. Credit three hours.

Text: Keown, *Mechanism.*

4f. MACHINE DRAWING. *Laboratory.* (Wallis)

The work of this course familiarizes the student with drafting room conventions as applied to machine drawing and is intended to prepare him as to drafting technique for the advanced work in machine design.

Prerequisites: Mechanical Engineering 1w, 2f and 2w.

Required in V. and VI.

Sophomore year, first semester, one laboratory per week. Credit one and one-half hours.

5f and 5w. BOILERS AND ENGINES. *Lectures.* (Dickerson)

This course takes up the consideration of the construction and operation of the various well known types of boilers and engines and their accessories. Under the boiler part is included chimneys and boiler settings; under the engine part is included the simple and multi-expansion Corliss engines, uniflow engines, steam turbines, and gas engines.

Prerequisites: Physics 1f, 2f, 3w and 4w.

Required in I., III., V., VI. and VII.

Junior year, first semester, three hours per week. Credit three hours.

Text: Spanker, Green and Marshall, *Elements of Steam Engineering.*

6w. STEAM LABORATORY. *Laboratory.* (Dickerson)

A laboratory course given to familiarize the student with the instruments used in engineering investigations, also to give training in securing data, reporting, and analyzing results obtained from experiments conducted on boilers and steam and gas engines.

Prerequisites: To accompany or to be preceded by Mechanical Engineering 5f and 5w.

Required in III., VI. and VII.

Junior year, second semester, three hours per week. Credit one and one-half hour.

7w. VALVE GEARS. *Lectures and Problems.* (Dickerson)

The study of Valve Gears is essentially a study of the relative motions and simultaneous positions of the piston, crank and valve of an engine. This course deals principally with the valve and valve diagrams, shaft governor, Corliss and poppet valve gears and the reversing gears as applied to steam engines.

Prerequisites: Mechanical Engineering 3f and 5f or 5w.

Required in V.

Junior year, second semester, two hours per week. Credit two hours.

Text: Fessenden, *Valve Gears.*

8w. MECHANICAL LABORATORY. *Laboratory.* (Dickerson)

A course similar to Mechanical Engineering 6w. This course also includes experiments on air compressors.

Prerequisite: To accompany or to be preceded by Mechanical Engineering 5f or 5w.

Required I. and VI.

Junior year, second semester, six hours per week. Credit three hours.

9f. POWER PLANTS. *Lectures and Laboratory.* (Dickerson)

This course attempts to cover the broad scope of classifying the various types of machines used in power plants according to their adaptability to service, space, economy, and cost; also to give the student some idea of the commercial side of engineering. A laboratory period gives opportunity for studying the general lay-outs and operation of power plants and also experimental data which is obtained from complete plant tests.

Prerequisites: Mechanical Engineering 5f or 5w and 6w or 8w.

Required in V. and VI.

Senior year, first semester, six hours per week. Credit four and one-half.

Text: Fernald & Orrok, *Engineering of Power Plants.*

9w. THERMODYNAMICS. *Lectures.* (Dickerson)

A course in theoretical thermodynamics, covering the laws and fundamental equations of gases and their application to the

steam engine. Also a discussion of the principles governing the action of air compressors, gas engines, refrigerating machines and steam turbines.

Prerequisites: Mechanical Engineering 5f or 5w and 6w or 8w.

Required in V. and VI.

Junior year, second semester, three hours per week. Credit three hours.

Text: Moyer and Calderwood, *Engineering Thermodynamics.*

11f. COMPRESSED AIR. *Lectures.* (Harris)

This course covers the theory of air compression, both in reciprocating machines and in centrifugal machines; also the measurement and transmission of air, and its application to the industries.

The problems include laboratory work in testing compressors and fans, determination of friction in pipes, flow through orifices, and the solution of problems, such as come up in practice.

Prerequisites: Mathematics 19f, Mechanical Engineering 5f or 5w and 6w or 8w.

Elective.

Senior year, first semester, three hours per week. Credit three hours.

Text: Harris, *Compressed Air.*

12f or w. WOOD WORK. *Laboratory.* (Bowen, Cole)

The work in the wood shop aims to train the student in the use of wood-working tools and machinery and to familiarize him with the properties of the common woods. All work is done from drawings. One hour of period is spent in explanations and demonstrations of both wood and metal working shop methods.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first semester, four hours per week. Credit two hours.

14f or w. FORGE WORK. *Laboratory.* (Bowen, Cole)

This course begins with simple exercises in drawing, upsetting, bending, twisting, punching, and welding. The work gradually becomes more difficult, such as making eye-bolts, chains, and tongs. Tool-making is then begun by making screwdrivers, hammers, chisels, and a complete set of lathe tools to be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. The student is made familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting

iron, steel, brass and stone. The final part of this work is the testing of rock-drills on different grades of steel used.

Prerequisite: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second semester, three hours per week. Credit one and one-half hours.

15w. INTERNAL COMBUSTION ENGINES. *Lectures.* (Dickerson)

This course includes the theory of Internal Combustion Engines as well as the construction and operating features of the various types of automobile, stationary oil engines of small sizes, Diesel and other engines of large types. The gas producer is also studied.

Prerequisites: Mathematics 19f, Mechanical Engineering 5f or 5w and 6w or 8w.

Elective.

Senior year, second semester, three hours per week. Credit three hours.

Text: Sterling, *Internal Combustion Engines.*

16w. FOUNDRY. *Laboratory.* (Bowen, Cole)

This course comprises instruction and practice in the use of foundry tools and equipment and in tempering of sand, preparation of sands for core binding and core making. It also includes bench, floor, pit, sweep, and machine molding; charging of cupola and pouring of metals.

Prerequisites: Mechanical Engineering 12f and 14w.

Required in V. and VI.

Sophomore year, first semester, three hours per week. Credit one and one-half hours.

17w. HEATING AND VENTILATING. *Lectures and Problems.* (Dickerson)

A study of the principles of design for heating and ventilating private and public buildings. An example is used for illustrating the various systems of furnace heating, hot water and steam and comparisons made. The central heating system is also studied.

Prerequisites: Mechanical Engineering 9w.

Elective.

Senior year, second semester, three hours per week. Credit three hours.

Text: Hoffman, *Handbook for Heating and Ventilating Engineers.*

18w. MACHINE SHOP. *Laboratory.* (Bowen, Cole)

This course begins with chipping to a line, filing to a dimension, and scraping to a surface plate. Machine operation is then begun; the principles and uses of the drill-press, lathe, planer, shaper, and milling machines are taught by lectures followed by practical work at each machine. After a reasonable time, skill is attained in operating the various machines through a course of graded exercises. In this work use is made of the vernier, micrometer, thread-micrometer, and gear-tooth caliper. Entire machines are also built, such as lathes, gasoline engines, wood trimmers. The degree of accuracy thus acquired enables the student to use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

Prerequisite: Mechanical Engineering 14f or 14w.

First or second semester, six hours per week. Credit three hours.

19w. INDUSTRIAL ENGINEERING. *Lectures.* (Dickerson)

This course comprises lectures on the construction and the arrangement of buildings for manufacturing plants; the heating and lighting of such buildings; the installation and arrangement of machinery in them and also the maintenance of plants is considered. Shop management is especially studied during the course.

Prerequisite: Mechanical Engineering 9f.

Required in V.

Senior year, second semester, three hours per week. Credit three hours.

20f. MACHINE DESIGN. *Laboratory.* (Dickerson, Duffy)

The individual shapes and strength of the working parts of machines are studied, keeping in mind the frame upon which these parts are to be assembled. Such problems as the design of bearings, clutches, hooks, pulleys and also machine tools as found in machine shops.

Prerequisites: Mechanical Engineering 3f, 4f, and 18w.

Required in V.

Junior year, first semester, three hours per week. Credit one and one-half hours.

Text: Halsey, *Handbook for Machine Designers.*

20w. ENGINE DESIGN. *Laboratory.* (Dickerson, Duffy)

In this course the student completely designs a steam or gas engine, making comparisons with "Manufacturers' Averages." The report includes the calculation and detailed drawings.

Prerequisite: Mechanical Engineering 20f.

Required in V.

Senior year, second semester six hours per week. Credit three hours.

Text: Halsey, *Handbook for Machine Designers.*

22f. MACHINE DESIGN. *Laboratory.* (Dickerson, Duffy)

This course takes up the design of the shapes and strength of the working parts of machines similar to that in 20f.

Prerequisites: Mechanical Engineering 3f, 4f, and 18w.

Required in VI.

Junior year, first semester, three hours per week. Credit one and one-half.

24f. POWER PLANT DESIGN. *Laboratory.*
(Dickerson, Duffy)

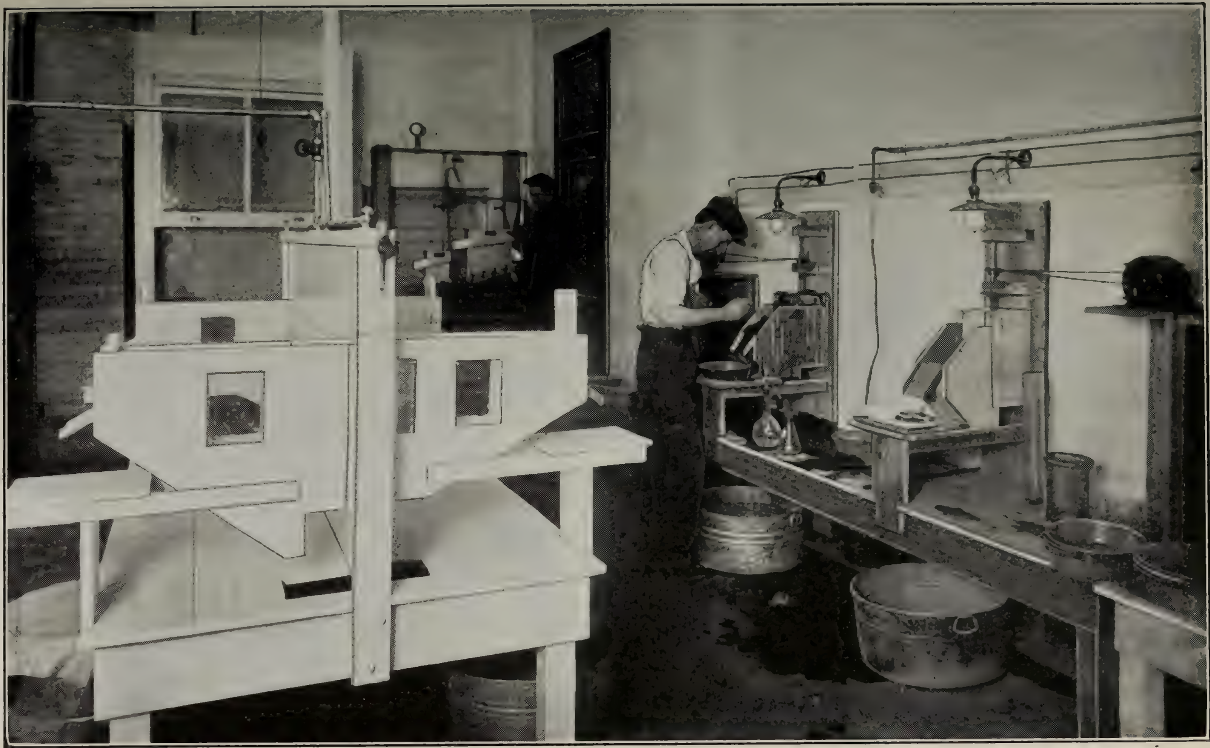
The student makes preliminary surveys, and from this, with what further data needed, designs a complete power plant. The generation and sale of the power as well as the by-products, such as steam for heating, are taken into account. Drawings for pro-plants are made and plans for reconstruction are worked up. Maintenance, stand by losses, insurance and depreciation are considered in the selection of the machinery.

Prerequisite: Mechanical Engineering 9f.

Required in V.

Senior year, first semester, six hours per week. Credit three hours.

ASSAY LABORATORY



FLOTATION LABORATORY

METALLURGY AND ORE DRESSING

ASSOCIATE PROFESSOR MANN, ASSISTANT PROFESSOR CLAYTON, MR. GILL, MR. MANESS.

Equipment.

The assay laboratory has a floor space of forty-eight hundred square feet. In the main room are twenty coal-fired, double-muffle assay furnaces, twelve gasoline-fired muffle furnaces, and ten coke-fired furnaces. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces.

A room 16 by 16 feet, separated from the furnace laboratory by glass partitions, is used for parting. There are in this room the necessary hot plates, acid jars, and annealing muffles. The desks in this laboratory are topped with white tiling.

The balance room is 20 by 20 feet and is lighted only from the north. It is easily kept at constant temperature. There are twenty-four balances suitable for weighing gold. A number of these balances have the multiple-rider attachment.

For chemical work in connection with metallurgy there is a well-lighted room having fifty-six lockers and fifty-six desks. Each desk is provided with gas, compressed air, and water. There is in the room ample hood space; in fact, the laboratory has everything necessary for general chemical work.

There is, in main furnace room, a circular water-jacket blast furnace 20 inches in diameter at the tuyeres and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster, an experimental zinc distilling furnace, direct reading and recording La Chatlier thermo-electric pyrometers, and a Wanner optical pyrometer.

A stock room, containing chemicals, clay goods, glassware, and other supplies, serves all the laboratories. The ore-sample room is especially well equipped. It contains more than 1,000 samples of ore of varied classes. Each sample is stored away in paper sacks, all ready for issuing to the students. Each sample has been prepared and carefully assayed. Enough of each lot of ore has been prepared to give 200 to 300 samples of the same lot. The ample room, therefore, contains more than 1,000 different samples

of ore, each sample being divided into 200 or more smaller samples, each of the smaller samples being ready for immediate issue.

Throughout the metallurgical and ore-dressing laboratories care has been taken that each furnace, each piece of apparatus, should be so arranged as to be fitted best for that testing work which must be so great a part of the student's work. In all the laboratory work, in addition to demonstrating the theories and principles explained in the classroom, the attempt is made to give the man ability to do a day's work and to teach him to use both his head and his hands.

The main floor of the ore-dressing laboratory occupies a space of forty-eight hundred square feet and a mezzanine floor provides an additional space of thirteen hundred square feet. The equipment of the laboratory is as follows: The crushing and sampling department contains a gyratory breaker, a Dodge breaker, a pair of 9-inch by 12-in. rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests are provided a three-stamp mill, with amalgamated plates and a 3½ foot Huntington mill.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a duplex Callow traveling belt screen, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, one Deister Overstrom table, and a laboratory James table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected, motor-driven centrifugal sand pumps are used for elevating finely crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a small gyratory breaker, a disc grinder, a coffee mill, a pair of rolls, a number of bucking boards and mullers, a laboratory tube mill, a RoTap testing Sieve shaker and an electric sample dryer.

The cyanide unit contains a laboratory leaching plant with all necessary tanks, a 16-in. Hendryx clay agitator, a 14-in. Hendryx combination agitator and filter, and a six-leaf 12-in. by 12-in. filter press.

Ores suited to a magnetic concentration are treated on a Knowles magnetic separator, and for the preparation of such ores a cylindrical dryer and roaster, together with a plane impact screen for dry sizing, is provided.

For testing ores by flotation, the laboratory is equipped with machines that represent the latest thing in the way of oil flotation. There are eight machines of the mineral separation type, four of which are of the modified air lift type, one Janney machine (the gift of D. C. Jackling), and one Callow machine. Each machine is arranged so that it can be run independent of all others or in combination.

The laboratory, which is lighted by two "daylight" nitrogen lamps, is well equipped with hot plates, drying areas, water and air pipes, and other equipment that goes toward facilitating work.

We have on hand about one hundred and fifty oils, most of which have been carefully classified according to their merits as flotation oils. Besides the oils, we have a large number of reagents that are used as addition agents in the flotation process.

Throughout the mill, wherever possible, the practice of driving each machine with an individual motor has been followed.

It is recognized that the school cannot give students, in the brief time at its disposal, that skill which comes from long practice but it is the aim to give such training in the fundamental principles and their application that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

1f. FIRE ASSAYING. *Lectures.* (Mann)

This course deals with the theory of fire assaying as practiced in the laboratory. The points discussed are outlined under Metallurgy 2w.

Prerequisites: Chemistry 1f and 2f.

Required in I.

Junior year, first semester, two hours per week. Credit two hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

1w. FIRE ASSAYING. *Lectures.* (Clayton)

This course deals with the theory of Fire Assaying as practiced in the laboratory. The points discussed are outlined under metallurgy 2w.

Prerequisites: Chemistry 1f and 2f.

Required in II and VII.

Junior year, second semester, two hours per week. Credit two hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals*

2w. FIRE ASSAYING. *Laboratory.* (Mann, Clayton, Gill)

This work includes the assay, by scorification and crucible methods of ores from the various districts of the United States. Copper ores, copper mattes, and copper bullions are assayed by fire and by the combination method. Lead ores and furnace products are assayed for lead and for gold and silver. Assays of cyanide solutions, of zinc-box residues, of silver bullion, of gold bullion, of lead bullion and of silver-mill precipitate, are included in this course. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying, the student studies the losses occurring. He learns the effects of different schemes of firing the furnaces by making analysis of the flue gases and by pyrometric measurements. The laboratory is so arranged that even with large classes a student is not hampered by other students and he learns to handle a large amount of work with the best utilization of his time.

Prerequisites: Chemistry 1f and 2f. To be preceded by Geology and Mineralogy 1f.

Required in II.

Junior year, second semester, nine hours per week. Credit four and one-half hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

2f. FIRE ASSAYING. *Laboratory.*

This course covers the work outlined in Metallurgy 2w briefly.

Prerequisites: Chemistry 1f and 2f. To be preceded or accompanied by Geology and Mineralogy 1f.

Required in I.

Junior year, first semester, six hours per week. Credit three hours.

4w. FIRE ASSAYING. *Laboratory.*

This course attempts to briefly cover some of the more important operations as outlined in Metallurgy 2w.

Prerequisites: Chemistry 1a and 2f.

Required in VII.

Junior year, second semester, three hours per week. Credit one and one-half hours.

5f. METALLURGY OF THE NON-FERROUS METALS.
Lectures. (Mann)

This course includes a study of the metallurgy of lead, copper, zinc, gold, silver, tin, antimony, and aluminum. The greater part of the time is spent on the metallurgy of lead, copper, zinc, gold, and silver.

METALLURGY OF LEAD. The course in the metallurgy of lead includes work along the following general lines: The properties and uses of lead, its alloys, and compounds. The ores of lead and methods and principles of their sale. Principles and practice of sampling ores and products. The general principles made use of in the winning of lead from its ores. The treatment of lead ores in the reverberatory smelting furnace. The winning of lead from its ores by smelting in the ore hearth or Scotch hearth, considerable attention being paid to this method on account of its importance with the ores of the Mississippi Valley. The roasting of lead ores and the strides that have recently been made in this important preliminary to the lead blast-furnace. The winning of ores in the lead blast-furnace. This heading is, of course, an important one in the subject, and under it are taken up the blast-furnace plant, the chemistry of the blast-furnace, the calculation of furnace charges, the calculation of costs of smelting, the handling of products, particularly the smoke or fume. The desilveration of base bullion by means of the Parkes, Pattison, and cupellation processes, as well as by the Betts process. Throughout this course, as well as the other courses in this department, the work is accompanied by problems which bring out the ideas that the classroom work considers.

Texts: Hofman, *Metallurgy of Lead.*
Collins, *Metallurgy of Lead.*
The Articles Appearing in the Technical Journals.

METALLURGY OF COPPER. The metallurgy of copper is considered along the following general lines: The properties and uses of copper, its compounds, and its alloys. The markets for copper and its ores and principles underlying their sale and price. The ores of copper. The smelting of roasted and oxidized ores of copper to black copper is touched only briefly. The roasting of copper ores as a preliminary to balst-furnace and reverberatory smelting. The handling of the smoke from copper furnaces to save the values contained therein and to remove from these gases their injurious constituents. The smelting of roasted ores to matte in the reverberatory furnace. The smelting of roasted ore to matte in the blast-furnace either with or without the attempt to volatilize a considerable portion of the sulphur. The smelting of raw massive sulphides to matte in the blast-furnace, or pyrite smelting. The converting of copper matte to blister copper in the basic and in

the acid converter. The furnace refining of copper. The production of copper from matte by the various roast-reaction of roast smelting methods. The electroyltic refining of copper.

Texts: Peters, *Practice of Copper Smelting.*
Peters, *Principles of Copper Smelting.*
Hofman, *Metallurgy of Copper.*
References in the Technical Journals.

METALLURGY OF ZINC. The metallurgy of zinc is considered under the following headings: The properties and uses of zinc, its alloys, and its compounds. The ores of zinc and the methods and principles underlying their sale. The roasting of zinc ores, with a brief study of the use of zinc ores as a source of sulphuric acid. The distillation of zinc ores and the furnaces suited for this purpose. The factors on which the success of the distillation depends. The manufacture of retorts and condensers. The laws of condensation of vapor to liquid and their application to the condensation of zinc vapors. The products of zinc smelting, and the methods of handling and treating these products. The cost of smelting zinc ores figured on the basis of a number of typical ores. The refining of spelter. The markets for spelter and the various brands of spelter. Special schemes other than the ordinary methods that have been used or proposed for use in the winning of zinc from its ores. The manufacture of zinc oxide pigment. Throughout the course problems are given to illustrate the ideas set forth in the class.

Text: Ingalls, *Zinc.*

METALLURGY OF GOLD AND SILVER. The metalurgy of gold. The work of this course includes lectures and recitations along the following general lines: The properties of gold, gold alloys, and the compounds of golds. The winning of gold from placer ground by dredging and hydraulizing, including methods of investigating the value of placers. The chlorination and bromination of gold ores are considered more in the light of the historic value of these processes than for their present importance as schemes of gold extraction. The amalgamation methods for silver and gold ores are taken up in detail in the course in ore dressing.

The metallurgy of silver is considered as suggested by the following headings: The properties of silver, of its alloys, and of the compounds of silver. The winning of silver from its ores by the various leaching schemes that were formerly of greater importance than at present. These schemes include the Augustin process, the Ziervogel or Argo process, the various methods of hyposulphite leaching; they are considered only briefly. The greater part of the time of the course in gold and silver is devoted to the study of the cyanide process, which is considered in considerable detail. The parting of gold and silver by the various acid and electrolytic schemes. The winning of gold and silver from their ores by the

various smelting schemes is considered under the head of the metallurgy of lead and copper.

Texts: Rose, *Metallurgy of Gold.*
Collins, *Metallurgy of Silver.*
Julian and Smart, *Cyaniding.*
Clennell, *Cyaniding.*
The Technical Journals.

Prerequisites: Metallurgy 39b and Chemistry 6b.

Senior year, first semester, four hours per week. Credit four hours.

Required in II.

5w. *METALLURGY OF THE NON-FERROUS METALS. *Lectures.* (Mann)

This is a continuation of Metallurgy 5f.

Prerequisites: Metallurgy 39w and Chemistry 6b.

Senior year, second semester, three hours per week. Credit three hours.

6f. METALLURGY. *Laboratory.* (Mann, Clayton)

This course covers the testing of ores for process treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixivation concentration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods woked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect that freight rates and such other factors have on the treatment which an ore should receive. Experiments are made in the reverberatory and the "pot" roasting of ores, and on blast-furnace smelting of ores. Furnace heat equations are made by each student from data collected by himself.

Prerequisites: Metallurgy 1w, 2w and 3w.

Senior year, first semester, four hours per week. Credit 2.5 hours.

Text: Howe, *Metallurgy Laboratory Experiments.*

8f. METALLURGY. *Laboratory.* (Mann)

A more extended course than 6f. Planned for students specializing in metallurgy.

Prerequisites: As in 6f.

*Students working for a degree in either mining or metallurgy who take this course are required to take the metallurgy portion of the Senior Trip. All other students taking this course must either take the metallurgy portion of the Senior Trip or do equivalent work in metallurgy at Rolla.

Senior year, first semester, seven hours per week. Credit four hours.

Recommended for II.

Text: As in 6f.

9f. ELECTRO-METALLURGY. *Lectures.* (Clayton)

Lectures are given covering the electro-metallurgical processes that are in use. Efficiency and engineering calculations based on these processes are given.

Prerequisites: Metallurgy 3w, Physics 1w and 3f, Chemistry 9f, 10f and 7f.

Senior year, first semester, four hours per week. Credit four hours.

10f. ELECTRO-METALLURGY. *Laboratory.* (Clayton)

This course gives a study of the principles of electro-metallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed and calculations as to efficiency are made on electric smelting.

Prerequisites: Physics 1w and 3f, Chemistry 9f, 10f and 7f Accompanied by Metallurgy 9f.

Senior year, first semester, six hours per week. Credit three hours.

10w. ADVANCED ELECTRO-METALLURGY. *Laboratory.* (Clayton)

This course is a continuation of Metallurgy 10f.

Prerequisites: Physics 1w and 3f, Chemistry 9f, 10f and 7f, Metallurgy 10f.

Senior year, second semester, three hours per week. Credit one and one-half hours.

12. SENIOR TRIP.

During the second semester of the Senior year a three weeks' trip is taken to Joplin, St. Louis, Flat River, and other points in the Southeast Missouri Lead District, for the purpose of studying the Mining, Ore Dressing, Smelting, Geology, and Power Plants of these districts. The metallurgy and ore dressing part of this trip are required of all candidates for degrees in Mining Engineering and Metallurgy who take Courses 5b Metallurgy and 33b Metallurgy.

Prerequisites: Metallurgy 5b, 33b.

Senior year, second semester.

13f. METALLURGY PROBLEMS. (Clayton)

These problems aim to cover the common ones that the metallurgist meets in practice.

Prerequisite: Metallurgy 3w. To accompany Metallurgy 5f

Senior year, first semester, three hours per week. Credit three hours.

Text: Richards, *Metallurgical Calculations.*

15w. METALLURGICAL MEMOIRS. *Lectures.* (Mann)

The student in the Metallurgy Curriculum's required to do considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by each student.

Prerequisite: Metallurgy 5f.

Senior year, second semester, one hour per week. Credit, one hour.

19f. METALLURGY PLANT. *Lecturea.* (Mann)

The arrangement of various metallurgical works are studied. The advantages and disadvantages of different equipments are given.

Prerequisites: Metallurgy 3w, 5f, and 5w

Graduate course, first semester, two hours per week. Credit two hours.

20f. METALLURGY PLANT DESIGN. *Laboratory.* (Mann)

This is a drafting-room course and the student is given problems to solve in detail, covering a partof the class room discussions. Each student is required to submit complete drawings, specifications and estimates of cost.

Prerequisites: Shop Practice and Drawing 2w, Metallurgy 3w, 5f, and 5w.

Graduate course, first semester, six hours per week. Credit three hours.

21w. CYANIDING. *Lectures.* (Mann)

This course teaches the principles and practice of cyaniding. The student keeps up wih the progress in the art. Attention is given in all the work to the cost of operation and to the schemes used and proposed for lessening the cost. A detailed study is made of the types of filter presses, crushing machinery, and other devices used in cyanide mills. Cyaniding is compared with other possible methods of treatment.

Prerequisites: Metallurgy 1w, 2w, and 3w.

Graduate course, second semester, three hours per week. Credit three hours.

22w. CYANIDING. *Laboratory.* (Mann)

The student in this course has an opportunity to test in the Laboratory the methods discussed in the classroom. The work is not routine, but the experiments are aranged to bring out a point under discussion, or to solve, if possible, the problems occurring at the time in the classroom.

Prerequisites: Metallurgy 1w, 2w, and 3w. To accompany Metallurgy 21f.

Graduate course, second semester, six hours per week. Credit three hours.

23w. ORE SUPPLY. *Lectures.* (Mann)

This course is intended to bring out the important subject of ore, flux, and fuel supplies. The subject is studied from a combined commercial and technical standpoint. The problems of valuing fluxes and fuels, of mixing ore so that the mixture shall command the lowest treatment rate, and of preparing, from the reduction works' standpoint, treatment charges for different classes of ores, are studied.

Prerequisites: Metallurgy 5f and 5w.

Graduate course, second semester, two hours per week. Credit two hours.

25f. METALLURGICAL RESEARCH. *Laboratory, Reading and Conferences.* (Mann)

Each graduate student elects a subject for special study. It is recommended that the work be along a different line from the subject chosen for thesis. The course consists principally of assigned reading, together with conferences with the professor on matter read. The laboratories are always open for the solving of any problem that may arise.

Prerequisites: Metallurgy 5f and 5w.

Graduate course, first semester, three hours per week. Credit three hours.

25w. METALLURGICAL RESEARCH. *Laboratory, Reading and Conferences.* (Mann)

This course is a continuation of Metallurgy 25f.

Prerequisite: Metallurgy 25f.

Graduate course, second semester, five hours per week. Credit five hours.

27w. ADVANCED METALLURGICAL PROBLEMS. *Lectures.* (Clayton)

This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions.

Prerequisite: 13f.

Second semester, one hour per week, crredit one hour.

29w. ALLOYS AND METALLOGRAPHY. *Lectures.* (Clayton)

These lectures deal with the theoretical and practical consideration that influence the structure and properties of alloys of different types.

Prerequisites: Chemistry 7f, Metallurgy 3w.

Senior year, second semester, three hours per week. Credit three hours.

30w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This laboratory course is given in connection with the lectures, and deals chiefly with the micro-structure of iron and steel.

Prerequisites: Chemistry 7f, Metallurgy 39w.

Senior year, second semester, three hours per week. Credit 1.5 hours.

32w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This course is intended for those who wish to devote more time to the study of the structure of Alloys than is possible with 30w.

Prerequisites: Chemistry 7f, Metallurgy 39w and 41w.

Senior year, second semester, six hours per week. Credit three hours.

33f. ORE DRESSING. *Lectures.* (Mann)

In this course the principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances. The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

Senior year, first semester, three hours per week. Credit three hours.

Text: Richards, *Textbook of Ore Dressing.*

33w. *ORE DRESSING. *Lectures.* (Mann)

This course is a continuation of Metallurgy 33f.

Prerequisite: Metallurgy 33f.

Senior year, second semester, four hours per week. Credit four hours.

Text: Richards, *Textbook of Ore Dressing.*

34f. ORE DRESSING PROBLEMS. *Laboratory.* (Mann)

In this course advanced work is given in connection with the design of plants and machinery for the treatment of ores. The course includes the determination of a practical process for treating a given ore, and the design for a mill for utilizing this process.

Prerequisites: Metallurgy 1w, 2w, and 31w, Shop Practice and Drawing 2w. To be accompanied by Metallurgy 33f.

Senior year, second semester, six hours per week. Credit three hours.

36w. ORE DRESSING LABORATORY. (Mann, Maness)

The student becomes familiar with the operation and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

Prerequisites: Metallurgy 1w, 2w, and 33f. To be accompanied by Metallurgy 33w.

Senior year, second semester, six hours per week. Credit three hours.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior Class take a three weeks' trip to Colorado and Utah, or other mining districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students, to be signed by the mine or

*Students in mining or metallurgy taking this course are required to take the ore dressing of the Senior trip. All other students are required to take the trip or do equivalent work in ore dressing at Rolla.

mill officials by whom he was employed, stating the time of such employment and nature of work.

Credit will be given for this course only to candidates for degrees of B. S. in Mining or Metallurgy.

Prerequisites: Mining 5w, Geology 3w, and Metallurgy 31w.

Junior year, Summer session. Credit six hours toward Senior electives in I. and II.

39w. GENERAL METALLURGY. *Lectures.* (Clayton)

This course is an introduction for the advanced metallurgical courses. The work is covered in a general way by the following headings: The properties of metals; the chemical equation from the standpoint of the metallurgist; methods of combustion; the temperature of combustion in any system and the effect thereon of certain variables; measurement of high temperatures; means of supplying oxygen for combustion, including stack design; metallurgical fuels and methods of firing, including a study of coals, coke, charcoal, gases from producers, and liquid fuels; calorimetry; refractories and their uses; types of furnaces and the reasoning involved in their design; a general study of typical metallurgical operations, including pyrometallurgical, hydrometallurgical and electrometallurgical processes; slags in general; conduction, radiation, and convection from the standpoint of the metallurgist. In this course much attention is given to the methods of attaching various metallurgical problems.

Prerequisites: Chemistry 3w and 4w, Geology and Mineralogy 1w.

Required in I., II. and VII.

Junior year, second semester, three hours a week. Credit three hours.

Texts: Fulton, *Principles of Metallurgy.*
Hofman, *General Metallurgy.*
Richards, *Metallurgical Calculations.*
Burgess and Le Chatelier, *The Measurement of High Temperature.*

40w. JUNIOR METALLURGY LABORATORY. (Clayton)

This course is intended for men following the metallurgy curriculum. It will take up in detail Pyrometry, Refractories, Fuel Testing, Gas Analysis, the Physical Properties of Metals, Cooling Curves, Roasting, Study of Slags, Use of the Microscope in Metallurgy and Ore Dressing, and Heat Conduction.

Prerequisites: To be accompanied by Metallurgy 39w.

Required in II.

Junior year, second semester, three hours per week. Credit one and one-half hours.

41w. METALLURGY OF IRON AND STEEL. *Lectures.* (Clayton)

This course is intended for those intending to follow metallurgy. It takes up in detail the study of iron and steel and the work follows these general headings: The properties of iron and its alloys and compounds; specifications for standard irons and steels; the ores of iron and the principles underlying their valuation; the preparation of iron ores for the blast-furnace; the iron blast-furnace, its construction and operation; the manufacture of pig iron; the properties of pig iron, and the factors upon which these properties depend; the calculation of furnace charges; the chemistry of the blast-furnace; the metallurgical operation of the blast-furnace; blowing engines; utilization of furnace gases; treatment of flue dust; heat balance of the operation of a blast-furnace; the manufacture of steels by the basic and acid bessemer, basic and acid open-hearth, crucible, and electric furnace methods; the manufacture of wrought iron; the constitution and structure of iron and steel; heat and mechanical treatment of steel; foundry practice; uses of steel products; and the study of special steels.

Prerequisites: General Metallurgy 39f.

Required in II., V. and VI.

Junior year, second semester, three hours a week. Credit three hours.

Texts: Stoughton, *Metallurgy of Iron and Steel.*
Sauveur, *Metallography of Iron and Steel.*
Carnegie, *Liquid Steel.*
Howe, *Iron, Steel, and Other Alloys.*
Richards, *Metallurgical Calculations, Vol. II.*

44w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This course is intended for men wishing to specialize in iron and steel.

Prerequisites: Chemistry 7f, Metallurgy 29w and 41w.

Senior year, second semester, nine hours per week. Credit four and one-half hours.

46w. ORE DRESSING PROBLEMS. *Laboratory.* (Mann)

This covers a portion of the work given in Metallurgy 34 b. It is intended for students wishing to spend a limited amount of time in mill designing.

Prerequisites: Metallurgy 1w, 2w and 33f.

Shop Practice and Drawing 2w. To be accompanied by Metallurgy 33f and 33w.

Senior year, second semester, three hours per week. Credit one and one-half hours.

MILITARY TRAINING

ASSISTANT PROFESSOR MUILENBURG*, MR. ARMSBY**.

By action of the Board of Curators instruction in Military Drill is prescribed for all physically fit students of the Freshman and Sophomore classes.

Each cadet is required to provide himself with a uniform consisting of the following:—Hat, blouse, breeches and leggings (all U. S. Army Regulation) and tan shoes. The cost of this uniform exclusive of shoes is approximately ten dollars.

In the absence of a United States Army Officer a Faculty Committee is in charge of the work.

Instruction is given by student officers under direct supervision of members of the committee and includes the following:

School of the Soldier, Squad, Company and Battalion in Close and Extended order; Manual of the Bayonet; Signalling, etc.

Practical instruction will be given four hours a week from the opening of school till weather conditions no longer permit. Following this one hour a week theoretical instruction will be given until the weather again permits a resumption of the outdoor training.

Members of the regular athletic squads of the School of Mines are excused from Military Drill while they are bona fide members of the squad.

The following prizes are awarded for excellence in military work:

A banner is awarded to the company winning a competitive drill held early in the spring. This remains the property of the winners for the remainder of the school year.

A medal is awarded to the student winning an individual competitive drill held at commencement time. This becomes the permanent property of the winner.

In addition to these, appointments as officers and non-commissioned officers are made to students showing special aptitude and ability for the work.

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*Colonel of Cadets, State University of Iowa, 1912-13.

**Major of Cadets, Pennsylvania State College, 1910-11.

ORGANIZATION 1917-18.

Staff.

Colonel .... G. A. MUILENBURG
Major .... H. H. ARMSBY
1st Lieutenant and Adjutant .... P. D. WILKINSON
1st Lieutenant, unassigned .... L. H. GOLDMAM

Company Officers.

	Company A.	Company B.
Captain..............	H. S. CLARK	H. F. SHORE
1st Lieutenant........	C. A. GETTLER	K. M. WRIGHT
2nd Lieutenant.......	J. G. MILLER	B. R. TUTT
1st Sergeant..........	R. S. WEIMER	J. R. STUBBINS

METALLURGY AND ORE DRESSING

MINE TUNNEL

MINING

Professor Forbes*, Professor Locke, Mr. Maness.

Equipment.

The mining lecture room, located on the first floor of Norwood Hall in the southwest corner of the building, is provided with a combination lantern, reflectoscope and moving-picture machine. The school has several hundred lantern slides of mining scenes and mining machinery, and motion films showing mining operations are obtained from the U. S. Bureau of Mines. Three rock drills in section, supported on a suitable frame, are kept in the classroom together with exhibits of explosives, rock-drill bits, wire ropes, safety lamps, mine-rescue apparatus and various other mining appliances.

A number of models illustrating mining methods, head frames, mine timbering, skip dumps, reversible mine fan, methods of locating drill holes in tunneling and rotary drill for coal mining, are on display in the mining laboratory and are used in connection with the lecture work.

The surveying equipment, already referred to under Civil Engineering, includes a number of mining transits with auxiliary telescopes which are used for the field work in mine surveying.

Laboratories.

To meet the needs of some of the more important phases of mining work four laboratories have been equipped as follows:

Mine-Rescue and First-Aid Laboratory.

In accordance with the safety-first movement that has been making such rapid strides in the last few years, it has been deemed advisable to establish a mine-rescue and first-aid laboratory, where instruction is given in the use of breathing apparatus and in first aid to the injured. The equipment consists of three helmets, including a Draeger, Fleuss and Westfalia, a pulmotor, and all necessary first-aid supplies and charts. The time devoted to this laboratory does not exceed one afternoon a week for six weeks, but this is sufficient to familiarize the student with mine-rescue

*On leave of absence.

apparatus and to give him a fair knowledge of the principles of first aid.

Rock-Drilling Laboratory.

On account of the importance of rock drilling in metal mining operations, and also because it can readily be carried on in the laboratory, much stress is laid on this branch of the work, for which the following equipment is used: Piston drills; Ingersoll-Rand $2\frac{1}{4}$-inch auxiliary-arc-tappet drill; Ingersoll-Rand C-110 Butterfly; Sullivan $2\frac{3}{4}$-inch tappet; Sullivan $2\frac{1}{4}$-inch differential valve, with steam and air front heads; Sullivan FF-12 with water attachments; Wood $2\frac{1}{4}$-inch spool-valve. Hammer drills: No. 7 Water Leyner; Stopers: Waugh 16-V; Sullivan DA-21 with reverse feed; Hand Hammer drills: Ingersoll-Rand Jack-hammer; Hardsocg; Cleveland; Ft. Wayne electric drill.

This equipment has been purchased from time to time as improvements have been made by the manufacturers, and although not complete, embraces most of the different types of air drills in use at present.

For the work of drilling, large blocks of red granite about 4x4x5 feet are imported from Southeast Missouri. Two drilling frames for supporting the machines on column and arm have been constructed—one under cover in a frame building, and the other out of doors.

For sharpening steel, besides the usual hand tools, there is a Leyner-Ingersoll 5-A sharpener with a complete assortment of dies and dollies for forming various-shaped bits, including the cross, X, Z, bull, five-point, six-point, eight-point, high-center and single and double-chisel bits, as well as parts for shanking Leyner, Jack-hammer and piston steels.

The work done in this laboratory consists in sharpening steel both by hand and with the sharpener, and in drilling with the various machines. No attempt is made to drill a great number of holes, but the work consists in measuring cutting speeds with different bits and air pressures, noting variations in length and number of strokes under varying conditions and measuring air consumption. For this purpose a Sullivan air meter is used, and an electrical device designed at the school is used for counting the number of blows of the drills.

The amount of time spent in the laboratory does not exceed three hours a week or one laboratory period for one semester in the regular course, but much use is made of it in thesis and experimental work.

Compressed Air Laboratory.

The use of compressed air is so important in mining operations that the school has deemed it advisable to equip this laboratory with apparatus that would be suitable not only for students' use, but also for purposes of research and investigation.

A Sullivan WB-2 straight-line air compressor of 290 cubic feet capacity supplies air for this laboratory as well as the rock-drilling laboratory, and a Laidlaw-Dunn-Gordon compressor, used by the school in pumping from a deep well, is in the same building and furnishes a different type for study.

Two large displacement tanks 15 feet high and 5 feet in diameter are used for making accurate measurements of air for the determination of orifice coefficients and various other experiments. Another interesting installation in this laboratory is a mine fan. This is a 36-inch single-inlet "Sirocco," directly connected to a 35 h. p. variable-speed motor, and has a capacity of 20,000 cubic feet per minute against a 4-inch water gauge. Two styles of runners with vanes at different angles are provided for experimental work. The fan is used in the regular laboratory work, where its efficiency is determined under varying conditions, and also for experimental work in air measurements, and the standardization of large orifices.

Mine Plants.

The mine plant is situated about one and one-half miles from the school, which was the nearest point available where rock of a suitable nature could be found. A tunnel is being driven into the hillside as shown in the engraving. The rock is a pitted dolomite.

The power plant for running the machine drills used in the tunnel consists of a 50 h. p. fire-tube boiler and an Imperial type 10 Ingersoll-Rand air compressor of 100 cubic feet capacity. Water for the boiler is pumped from a near-by stream with a centrifugal pump driven by a 3 h. p. Ferro, two stroke per cycle, gasoline engine. A 5x7 Davis and Rankin steam engine and a 3.6 kw. 110-volt United States dynamo furnishes electricity for lighting the plant and for operating an electric drill. This unit has an interesting historical value. In 1892 it furnished all the power for the shop and for the dynamo laboratory, which were then located in the basement of the Rolla building.

In designing the power plant, an endeavor was made to introduce as great a variety of machinery as possible, as the operation of the plant is considered one of the most valuable features of this work.

The total time spent in the mine-plant laboratory is about the same as in the rock-drilling laboratory, but instead of working the usual three-hour period, from nine to twelve hours are put

in at a time, as a three-hour period is entirely too short for this kind of work.

The work is largely experimental, and consists in using different explosives and analyzing their products of combustion; trying out different methods of placing holes for blasting and different methods of setting off blasts; time studies of drilling operations are made, and cost-records of the work are required. In addition to this, the work of sharpening steel, timbering, mucking, track laying and hand drilling, together with the experience of running the power plant, affords a greater variety of work than can ordinarily be had in a reasonable length of time in practice. It is not the aim in this work to make drill runners or miners out of students, but to give them a greater familiarity with mining tools and methods than is obtainable from books or mere observation.

3f. MINING. *Lectures.*

A study of rock excavation, including rock drilling, explosives and blasting, supporting excavations, tunneling and shaft-sinking. Written reports are required on each subject as completed.

Prerequisites: Mechanical Drawing 2w, Physics 1w.

Required in I. and III.

Junior year, first semester, three hours per week. Credit three hours.

Texts: Young, *Elements of Mining.*
Foster, *Ore and Stone Mining.*
Donaldson, *Shaft Sinking.*
Weston, *Rock Drills.*
Current Technical Journals.
Publications of U. S. Bureau of Mines.

Not given in 1917-18.

5w. MINE SURVEYING. *Lectures.*

The theory and practice of mine surveying are presented by lectures. The methods of carrying azimuth underground under different conditions are studied in detail, including shaft plumbing and the use of the auxiliary telescope. Notes of a complete mine survey are given the student, from which all calculations must be made and maps drawn. Other problems involving the strike and dip of veins are introduced, including the determination of intersection of veins, length of tunnels to intersect veins at depth, and the determination of strike, dip and thickness of veins from bore-hole data.

Prerequisite: Civil Engineering 2f.

Required in I.

Junior year, second semester, two hours per week. Credit two hours.

Text: Durham, *Mine Surveying.*

Not given in 1917-18.

6w. MINE SURVEYING. *Problems.*

One afternoon per week is devoted to the solution of problems in mine surveying and to making mine maps.

Prerequisite: Must be accompanied by Mining 5w.

Required in I.

Junior year, second semester, three hours per week. Credit ~~one~~ and one-half hours.

Not given in 1917-18.

11w. MINING. *Lectures.* (Locke)

This is a continuation of the work of the Sophomore year, and includes the study of mining methods, sampling and estimation of ores, mine valuation, and a study of mining costs. The principles of mining law are also reviewed.

Prerequisites: Mining 3f, Geology 9f.

Required in I.

Senior year, second semester, three hours per week. Credit three hours with senior trip; two and one-half hours without trip.

Texts: Hoover, *Principles of Mining.*
Finlay, *The Cost of Mining.*
Current Technical Journals.

12. SENIOR TRIP.

During the second semester of the Senior year, a two weeks' trip is taken to Joplin or to St. Louis, Flat River, and other points in the southeast Missouri lead district, for the purpose of studying mining, ore dressing, smelting, geology, and power plants of these districts. Several days are devoted to practical work in mine surveying during which time a complete survey and map of some portion of a mine is made.

Required for graduation in Curriculum I.

13w. MINE VENTILATION *Lectures.*

A study of the various gases met with in mines, their origin, effects and detection; the amount of fresh air required for men and animals under varying conditions; natural and artificial means of ventilation; gas and dust explosions, and mine-rescue work. A large part of the course is devoted to problems in mine ventilation.

Prerequisites: Mining 3f and Physics 3f.

Senior year, first semester, three hours per week. Credit three hours.

Not given in 1917-18.

16f. MINING LABORATORY. (Maness, Flanders)

Laboratory work in rock drilling and blasting, timbering, sharpening steel, track-laying, and operation of mine power plants.

Reports are required on all work. A study of mine-rescue apparatus and first aid to the injured is included in this course.

No credit will be allowed in mining laboratory except in Curriculum I.

Prerequisite: Must be accompanied by Mining 3f.

Required in I.

Junior year, first semester, three hours per week. Credit one and one-half hours.

16w. MINING LABORATORY.

A continuation of the laboratory work of the Junior year. A feature of this work is the keeping of accounts and cost records of tunnel driving as a training in the study of mine accounting.

No credit will be allowed in mining laboratory except in Curriculum I.

Prerequisites: Mining 3f, 16f; Civil Engineering 27f; must be accompanied by Mining 17f.

Senior year, second semester, three hours per week. Credit one and one-half hours.

Not given in 1917-18.

17w. MINING CONFERENCE. *Lectures.*

The conference consists in discussions relative to the mining laboratory work and lectures on mine accounting and bookkeeping. Reports are prepared by the student on various assigned subjects and presented to the class.

Prerequisites: Must be accompanied by Mining 16w.

Senior year, second semester, one hour per week. Credit one hour.

Not given in 1917-18.

19w. MINING ECONOMICS. *Lectures.*

Various economic problems of interest to mining engineers are studied. The influence of mining in the history of America and especially in United States history is reviewed and the relation of mining to other industries is considered. The organization of the mining industry, the conservation of the mineral resources, and various problems in economics, including mining labor, wages, capital, taxation, profit-sharing, and employers' liability are presented by lectures and assigned reading.

Prerequisites: Mining 11w, Geology 9f.

Graduate course, first semester, one hour per week. Credit one hour.

Not given in 1917-18.

20f, 20w. MINE PLANT DESIGN. *Laboratory.*

This is a drafting-room course and is supplementary to all the previous mining courses. Each student is required to prepare complete drawings for the equipment of a given mine. Bills of material, specifications, and complete estimates are submitted.

Prerequisites: Mining 11w and Civil Engineering 15f.

Graduate course, first and second semesters, six hours per week. Credit six hours.

23f. MINING LAW. *Lectures.* (Locke)

A study of the mineral land laws of the United States and laws affecting the operation of mines, including workmen's compensation acts.

Prerequisites: Completion of the Junior year in Curriculum I.

Senior year, first semester, one hour per week. Credit one hour.

25w. OIL AND GAS. *Lectures.*

A study of well-drilling and oil-production methods.

Prerequisite: Geology 17f.

Senior year, second semester, one hour per week. Credit one hour.

Text: Paine and Stroud, *Oil Production Methods.*

Not given in 1917-18.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior Class take a three weeks' trip to Colorado and Utah, or other mining districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students, to be signed by the mine or mill officials by whom he was employed, stating the time of such employment and nature of work.

Credit will be given for this course only to candidates for degrees of B. S. in Mining or Metallurgy.

Prerequisites: Mining 5w, Geology 3w, and Metallurgy 31w.

Required in I.

Junior year, Summer session.

PHYSICS AND ELECTRICAL ENGINEERING

PROFESSOR MCRAE, ASSISTANT PROFESSOR BLACKWOOD, MR. FRAME*, MR. ZEUCH.

Equipment.

The lecture room and laboratories for Physics and Electricity are in Norwood Hall. The lecture room will seat one hundred students and is provided with water, gas, and electric connections for conveniences in lecture demonstrations and experiments.

The physical laboratory is on the ground, or basement, floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound, and heat, and one equipped for electric measurements. There is a battery room equipped with both primary and secondary batteries connected by wire with the various laboratories and the lecture room; a constant-temperature room with double walls and air space insulation; a commodious dark-room with blackened walls for spectrometric and photometric measurements, and a special laboratory for research work.

The equipment includes a Rowland electro-dynamometer with shunts and resistances; a Leeds and Northrup standard potentiometer with shunts and voltage coils; a Leeds and Northrup decade wheatstone bridge; a Queen post office pattern wheatstone bridge; a Leeds and Northrup ohmmeter; various wheatstone bridges and resistance boxes; standards of resistance and inductance; paper and mica condensers; various tangent, mirror, and ballistic galvanometers; a Duddell thermo-galvanometer; a Dolezalek quadrant electrometer; a Lummer-Brodhun photometer; a Bunsen photometer; a Gaetner dividing engine with linear and circular attachments; a Threlfall micro-manometer; a Dietzgen anemometer; a ten-inch induction coil; Crookes tubes; cathode and X-ray tubes; a Van Hooten and Tenbroeck electrostatic machine; a wireless demonstration set; a Gaetner electroscope for radio-active measurements; a Schmidt & Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; an Ives photograph of a Rowland grating; various balances; calorimeters; micrometers, calipers, together with apparatus for illustrating the principles of physics.

*On leave of absence.

The steam laboratory equipment includes Parr and Roland-Wild coal calorimeters; Ellison throttling and evaporating moisture calorimeter; Peabody, and Schaeffer and Budenberg moisture Calorimeters; General Electric Co., and Gebhardt portable steam flow meters; Hays, and Orsat flue gas apparatus; Crosby, Thompson, Robertson, Schaeffer and Budenberg, and American steam and gas engine indicators; Schaeffer and Budenberg continuous drum indicator; Amsler, Willis, and Keuffel and Esser planimeters; various indicating and recording steam gages; Crosby steam gage tester; Tycos portable pyrometer; three water meters; thermometers, manometers, tachometers, and speed counters; Prony end friction brakes.

The dynamo laboratory contains an assortment of direct current generators and motors, a General Electric double current generator for direct current and alternating current work, a single and a three-phase generator, an induction motor, a single-phase repulsion motor, a rotary converter, stationary transformers, three-phase to two-phase transformers, Cooper-Hewitt mercury converters, a General Electric electrolytic motor-generator set, a remote control starting box, testing instruments, which include a Weston laboratory standard voltmeter with multipliers; a Weston laboratory standard millivoltmeter with shunts; Kelvin electrostatic stationary and portable voltmeters; Weston portable ammeters and voltmeters; Weston portable milli-voltmeters with shunts, and milli-ammeters with resistances; Weston, Thomson, and Westinghouse portable direct current and alternating current voltmeters; Weston and Thomson portable watt meters; Westinghouse portable poly-phase wattmeter; Westinghouse portable single and polyphase watt-hour meters; Westinghouse portable voltmeters and ammeters with transformers; General Electric edgewise type alternating current voltmeters, ammeters and watt-hour meters, electrodynamometers; Grassot fluxmeter; portable resistance grids, inductance coils, and condensers.

The various electrical motors used for power purposes in the shops and laboratories are available for testing in addition to the machinery in the dynamo laboratory. The total electrical equipment includes thirty-five motors, varying in size from ½ h. p. to 35 h. p., with the aggregate rating of 225 h. p.

The power plant is also used for experimental purposes, and comprises a strictly modern and thoroughly equipped laboratory. The machinery available for testing purposes includes four 130-h. p. Heine safety boilers, one of which is especially equipped with openings in the setting for temperature and draft measurements in furnace, combustion chamber and flues; a 13 by 14 Erie Ball engine direct connected to a 75 kw. 220 volt D. C. Westinghouse generator; a 10 by 12 Ideal engine direct connected to a 50 kw. 220 volt D. C. Westinghouse generator; a 12 by 11 General Electric

marine type engine direct connected to a 50 k. v. a. 220 volts, 60 cycle, three phase generator with direct connected exciter; a 10 kw. 220 volt Curtis steam turbo generator; a 9 by 14 Brownell engine equipped with a rope friction brake; a 5 by 7 Davis and Rankin vertical engine equipped with a Prony brake; a 21-h. p. Otto four strokes per cycle gas engine belted to a General Electric 15 kw. 220 volt D. C. inter-pole generator, and to a two stage Worthington centrifugal pump; a 3-h. p. Ferro two strokes per cycle portable gas engine; a D. C. switchboard with a panel for each generator and two for distribution switches, equipped with a Tirrill voltage regulator, a Thomson recording watt-hour meter, circuit breakers for each generator, and the usual ammeters and voltmeter; an A. C. switchboard with voltmeter, ammeters, wattmeter, and watt-hour meter. The pneumatic equipment includes a Laidlow-Gunn-Gordon air compressor, a Rand Imperial air compressor, a Sullivan straight-line two-stage air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, a 60-inch Buffalo forge blower, an experimental fan capable of delivering 250 cu. ft. of air per second at six inches of water pressure, two cylindrical steel tanks 6 ft. by 15ft. for measuring air by water displacement.

There is a complete steam and pumping plant at the experimental mine, where laboratory practice is also obtained.

Courses.

1f. GENERAL PHYSICS. *Lectures.* (Blackwood)

The work in general physics begins with the study of kinematics, statics, kinetics, and the mechanics of fluids. The term's work concludes with the study of heat, including an introduction to thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of such subjects as sound, light, and alternating currents of electricity.

Prerequisites: To be preceded by or accompanied by Mathematics 9f, 11f and 11w.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first semester, three hours per week. Credit three hours.

Text: Spinney, *A Textbook of Physics.*

2f. GENERAL PHYSICS. *Laboratory.* (Blackwood, Zeuch)

The laboratory is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them.

Prerequisite: Mathematics 7w, and must be preceded or accompanied by 1f.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first semester, three hours per week. Credit one and one-half hours.

3w. GENERAL PHYSICS. *Lectures.* (Blackwood)

This is a continuation of course 1w and includes the study of electricity and magnetism, sound and light. Particular stress is laid upon electrical potential, resistance, and impedance, and upon the reflection, refraction, and interference of waves. Lectures, illustrated by experiments, and recitations.

Prerequisites: To be preceded by or accompanied by Mathematics 9f and 11f. Physics 1f.

Required in I., II., III., V., VI. and VII.

Sophomore year, second semester, three hours per week. Credit three hours.

Text: Spinney, *A Textbook of Physics.*

4w. GENERAL PHYSICS. *Laboratory.* (Blackwood, Zeuch)

The work in the laboratory deals with the subjects studied in Physics 3w and the method is the same as that outlined in Physics 2f.

Prerequisite: Must be preceded or accompanied by Physics 3w.

Required in I., II., III., V., VI. and VII.

Sophomore year, second semester, three hours per week. Credit one and one-half hours.

7f, 7w. PRINCIPLES AND PRACTICE OF ELECTRICAL ENGINEERING. *Lectures.* (McRae)

This course discusses the magnetic circuit of dynamos and motors, methods of testing and connections for operation of direct current dynamos and motors, of single and polyphase alternating current generators, of induction and synchronous motors, of stationary transformers and rotary converters, and the effects of frequency, resistance, inductance and capacity upon the impedance of alternating current circuits. During the latter part of the course the design of electrical transmission lines is studied, accompanied by the analytical and graphical solution of practical problems.

Prerequisites: Physics 1f and 3w.

Senior year, elective, first and second semesters, three hours per week. Credit three hours.

Texts: Gray, *Principles and Practice of Electrical Engineering.*
Pender, *Principles of Electrical Engineering.*

8f, 8w. DYNAMO LABORATORY. (McRae)

This course accompanies course 7f, 7w, and consists of calibration of instruments, measurements of ohmic and reactive resistances, insulation resistance and dielectric strength, regulation and efficiency tests, of dynamos, motors, transformers, and converters.

Prerequisites: Physics 1f and 3w.

Senior year, elective, first and second semesters, three hours per week. Credit one and one-half hours each semester.

9f, 9w. ELECTRICITY AND MAGNETISM. (Frame)

This course is designed as an introduction to the study of electricity and magnetism.

Prerequisite: Mathematics 3f.

Elective, first semester, lectures and recitations, five hours per week. Credit five hours.

Second semester, four recitations per week. Credit four hours.

Text: Timbie, *Elements of Electricity.*

Not given in 1917-18.

10w. ELECTRICAL LABORATORY. (Frame)

This course includes elementary tests in electrical and magnetic circuits, measurements with ammeters, voltmeters and wattmeters, and practice in wiring, connecting up lamps, motors and transformers.

Prerequisite: Physics 3w or 9f.

Sophomore year, second semester, six hours per week. Credit three hours.

Not given in 1917-18.

11f, 11w. ELECTRICAL MACHINERY. *Lectures.* (Frame)

During the first semester this course takes up a detailed discussion of armature windings. The second semester is given to the study of various types of control apparatus.

Prerequisites: Physics, 3w and 4w.

Required in V.

Senior year, first and second semester, two hours per week. Credit four hours.

Not given in 1917-18.

12f, 12w. ELECTRICAL MACHINERY LABORATORY. (Frame)

This course accompanies 11f, and 11w, and consists of practice in armature winding and a study of control apparatus.

Prerequisites: Physics 3f and 4f.

Required in V.

Senior year, first and second semesters, three hours per week. Credit three hours.

Not given in 1917-18.

13f, 13w. ALTERNATING CURRENTS. (McRae)

A continuation of Physics 7w and includes a rigorous analytical treatment of the subject as well as a study of the various practical applications in mining and metallurgy.

Prerequisites: Physics 7w and 8w.

Elective, first and second semesters, five hours per week. Credit ten hours.

Text: D. C. and J. P. Jackson, *Alternating Currents and A. C. Machinery.*

Not given in 1917-18.

19w. ELECTRIC DISTRIBUTION. (Duffy)

This course brings before the student problems of location of power house, size of conductors and transformers, lightning arresters, costs of systems and wiring for lights and power.

Prerequisites: Physics 7f and 7w.

Required in VI.

Senior year, second semester, three hours per week. Credit three hours.

Not given in 1917-18.

21f. ELECTRIC RAILWAYS. (McRae)

The railway motor and auxiliaries; train performance; interurban railways, signal service; and estimated costs of the different parts of the system are gone into in this course.

Prerequisites: Physics 7f and 12w.

Required in V.

Senior year, second semester, five hours per week. Credit five hours.

Not given in 1917-18.

PHYSICAL TRAINING

MR. McCONNELL, MR. HIGLEY, MR. BRUCE, MR. DOWD, MR. DORRIS, MR. JOHNSTON, MR. STEVENS, MR. SWAYZE.

For the physical training of students excellent opportunities are offered by the Jackling Gymnasium and the Jackling Field. The former, completed in 1915, at a cost of seventy thousand dollars, is a strictly modern fireproof building and is equipped with baths, dressing rooms, lockers, a swimming pool 20 feet wide and 60 feet long and various kinds of apparatus and game courts usually found in modern gymnasiums. Class work, consisting of setting-up exercises, developing exercises, calisthenics, the use of dumb-bells, clubs, and wands is given under the supervision of the Director of Physical Training. The aim of this work being to develop health, strength and vitality.

Jackling Field, constructed in 1909, by virtue of a gift of Mr. D. C. Jackling, '92, adjoins the gymnasium and provides a football gridiron, a baseball diamond, and a quarter-mile running track for class and intercollegiate games and events. A number of tennis courts about the campus are maintained in good order.

The School encourages rational athletics and a participation in intra and intercollegiate sport, all branches of which are under the direct supervision of the Director of Physical Training and management of the Board of Control. The membership of the Board of Control consists of the Director of Physical Training, the Chairman of the Faculty Committee on Athletics and the President and Student Manager of the Athletic Association.

The personnel of the Board of Control for 1917-1918: Mr. McConnell, Professor Cox, F. A. Krause, '19, F. Deckmeyer, '19, and Edw. Kahlbaum, Ex-Officio Treasurer of the Athletic Association.

GYMNASIUM

SWIMMING POOL

EXCURSIONS

The State of Missouri occupies an important place in the mining industry, leading in the production of lead, zinc, cobalt, nickel, barite, and tripoli. Many opportunities are offered students at the School of Mines and Metallurgy for keeping closely in touch with the mining industry of Missouri and adjoining States. There have been many important developments during the last few years in methods of mining, dressing, and smelting lead and zinc ores. The lead district of Southeast Missouri and the zinc district of Southwest Missouri offer numerous examples of up-to date practice in mining and metallurgical engineering. The aggregate tonnage capacity of the concentrating plants of Missouri is greater than that of any other state of the Union. The importance of modern methods of ore dressing is everywhere recognized, and the facilities offered by the School of Mines for investigation in ore dressing, together with the practice in concentrating plants which are visited, places the School of Mines and Metallurgy in the foremost rank in this important branch of mine engineering.

During the summer the Junior class makes a trip to Colorado and Utah, visiting Denver, Idaho Springs, Central City, Georgetown, Silver Plume, Montezuma, Breckenridge, Leadville, Colorado Springs, Cripple Creek, Victor, and Pueblo in Colorado, and Salt Lake City, Garfield, and Bingham in Utah. Special attention is given to mining practice in the Clear Creek District, the Cripple Creek District, and Leadville and vicinity. Amalgamation is studied in the Clear Creek District, cyanidation at Colorado Springs and Victor; smelting of gold, silver, copper, and lead ores at Leadville and Pueblo; iron and steel metallurgy at Pueblo; treatment of zinc ores at Leadville.

Special attention is paid on these trips to general engineering problems, plant design, economy of operation, and organization.

During the Senior year a trip is made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast-furnace practice. Here may be studied the blast-furnace, regenerative stoves, blowing machinery, power plant, and other appliances necessary for the production of pig iron. Open-hearth steel methods and the manufacture of steel castings are studied at the plant of the Scullin Steel Co. This plant includes, in addition to the usual type of open-hearth furnace, Bessemer converters, cupolas, and gas-producers.

The metallurgy of zinc is studied at the Edgar Zinc Works at Carondelet, where the roasting of blende and distillation methods may be seen. The Federal Smelter, at Alton, is visited for the study of lead smelting. At this plant the lead blast-furnace, the Huntington-Heberlin roasting system, and the Scotch ore-hearths are carefully inspected. This plant also includes an extensive bag house. The manufacture of white-lead paint and of lead pipe is seen at the National Lead Works. A further study of lead smelting is made at Herculaneum, where blast furnaces are served by Dwight-Lloyd roasters. At the various plants enumerated, particular attention is paid to construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Company. This plant is one of the largest clay manufacturing works in the world and a metallurgist here has a splendid opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

The class visits Southeast Missouri to study the geology, methods of mining, and the milling of great disseminated lead deposits. The geological work of this trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernible in relation to the contact plane between the pre-Cambrian and the Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain give interesting study in the distribution and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rock in conjunction with jointing and stratification is well illustrated.

The concentration plants of Southeast Missouri are large and modern, containing crushers, rolls, elevating machinery, Wilfley tables, Frue vanners, jigs, and sundry other machines. The mining plants are thoroughly modern and include steam and electric hoists, modern steel head-frames, compressed air and electric haulage, extensive pumping plants, and numerous diamond-drill prospecting equipments.

In Southwest Missouri the geology, mining and milling of the shallow deposits as well as of "sheet" ground are studied by the Seniors. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electrical power to mining and milling is well illustrated in this

district. Short trips are made to neighboring camps in Southwestern Kansas.

In 1918 the senior class was given the option of taking the excursion as outlined above or of attending the sessions and excursions of the American Institute of Mining Engineers, of which they are Junior members, at its annual meeting which was held at St. Louis, Mo., Joplin, Mo., Miami, Okla., and Tulsa, Okla. Here articles concerning mining, milling, metallurgy, geology and the petroleum industry were read and discussed. The sessions were of additional interest because of the presence of the National War Minerals Committee, and the discussion of the needs and plans of the Government to secure various ores to meet the conditions caused by the present war.

From St. Louis trips were made to the By-product coke plant of the Laclede Gas Light Company, to the plant of the Laclede-Christy Clay Products Company, to that of Evans-Howard Fire Brick Company, to the smelter of the St. Joseph Lead Company at Herculaneum, to the coal mines at Nokomis, Ill., and to the plants of the National Enameling & Stamping Company, Commonwealth Steel Company, American Steel Foundries, Wagner Electric Company, Curtis Manufacturing Company, American Zinc, Lead and Smelting Company and the Diesel Engine Company.

At Arcadia, Kan., opportunity was given to see the method of stripping coal by the use of steam shovels. At Webb City, Mo., and Miami, Okla., the occurrence of the zinc and lead ores together with the methods of mining and milling were studied. From Tulsa, Okla., visits were made to the Cosden Oil Refining, and to the oil fields and gasoline plants near Cushing.

GENERAL INFORMATION

Fraternities.

There are five Greek-letter college fraternities, each maintaining a chapter house: Gamma XI of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha and Alpha Delta Zeta of Lambda Chi Alpha.

The engineering scholarship fraternity, Tau Beta Pi, established its Missouri Beta chapter in the School in 1908; and in 1916 the professional engineering fraternity, Theta Tau, installed its Iota chapter.

Y. M. C. A.

The organization this year has had a membership of 148. It stands for the best there is in college life and brings together those who believe that college men should develop well-rounded characters, physical, mental, and spiritual. During the opening days of the college the members of the Association devote themselves to the very practical service of meeting new men at the trains, helping them to secure living quarters, and aiding them in getting a good start in school. The Association occupies commodious and well-appointed quarters on the first floor of Parker Hall, where all students are welcomed and where the regular meetings are held.

The Officers of the Association for 1916-1917 were:

C. L. Epperson, '18.............................*President.*
R. W. Mellow, '18.............................*Vice-President.*
I. B. Johnston, '20.............................*Secretary.*
H. Weiser, '19.............................*Treasurer.*

The Officers of the Association for 1917-1918 are:

I. B. Johnston, '20.............................*President.*
E. R. Housholder, '18.............................*Vice-President.*
H. Weiser, '19.............................*Treasurer.*
J. R. Stubbins, '20.............................*Secretary.*

The Missouri Mining Association.

The objects of the Mining Association are: To advance the knowledge of mining among its members; to promote good fellowship among the students and alumni of the School of Mines and

others interested in mining; and to bring the School into closer relation with the mining profession at large. Students in the School of Mines who have sixty-three credit hours on their course and alumni are eligible to membership.

This association is affiliated with the American Institute of Mining Engineers, and any member of it may become a junior member of the Institute. Such membership carries with it most of the privileges of regular membership at about one-half of the cost and with no initiation fee.

Twenty-nine members of the Missouri Mining Association are members of the American Institute of Mining Engineers. The total membership of the American Institute of Mining Engineers is over 5,000, one-fortieth of whom are Missouri School of Mines and Metallurgy men.

Officers of the Association for the year 1917-1918 are:

E. R. Housholder, '18........................*President.*
O. N. Maness, '18........................*Vice-President.*
W. H. Reber, '18........................*Secretary.*
R. Chavez, '18........................*Treasurer.*

Metallurgical and Chemical Society.

The Society meets fortnightly for the consideration and discussion of addresses, lectures, and informal talks on metallurgical and chemical topics,—theoretical, practical, and industrial,—delivered by students, faculty, and visiting professional men.

Students of metallurgy or chemistry with at least forty-three hours credit are eligible as active members; other students having forty-three hours credit or more may become associates.

The Officers for 1917-1918 are:

B. G. Nichols, '19........................*President.*
E. D. Wilson, '18........................*Secretary-Treasurer.*

Student Council.

The Student Council has for its object the promotion of various student enterprises and activities, and the maintenance of a spirit of mutual confidence in the student body and the faculty. The Council is composed of three Seniors and two Juniors, selected by the entire student body.

The Members of the Council for 1917-1918 are:

H. S. Clark, '18........................*President.*
Walter Scott, '19........................*Vice-President.*
H. Doennecke, '18........................*Secretary-Treasurer.*
W. H. Reber, '18........................
F. A. Krause, '19........................

Athletic Association.

The object of the Association is to unite the various efforts of the School in athletic sports. All students pay an athletic fee of five dollars a semester, which entitles them to membership in the Athletic Association, to admission to all athletic contests held under the auspices of the Athletic Association, and to gymnasium privileges. Members of the Faculty may become members of the Association by the payment of the stipulated fee. The Association elects its own officers and has general charge of all school athletics. The financial affairs of the Association are handled by a Board of Control. See page 132.

The Officers of the Association for 1917-1918 are:

F. A. Krause, '19........................*President.*
Edw. Kahlbaum, Registrar..............*Treasurer.*
F. Deckmeyer, '19........................*Business Manager.*
F. H. Taylor, '20........................*Cheer Leader.*
E. M. Guy, '21........................*Assistant Cheer Leader.*

The Rollamo.

The Rollamo, first published in 1907 by the fraternities, is now edited by a staff chosen from the entire student body. The publication is the official yearbook of the school, and chronicles in permanent form the activities of the school year.

The Board for 1917-1918 consists of the following:

W. H. Reber........................*Editor-in-chief.*
R. M. Stubbs........................*Associate Editor.*
M. J. McCarthy........................*Associate Editor.*
E. D. Wilson........................*Associate Editor.*
O. Gotch, Jr........................*Staff Photographer.*
E. E. Ashlock........................*Art Editor.*
F. A. Krause........................*Business Manager.*
N. B. Larsh........................*Asst. Business Manager.*
R. J. Dowd........................*Asst. Business Manager.*
O. N. Maness........................*Advertising Manager.*
F. H. Geib........................*Athletic Editor.*
Edw. Kahlbaum........................*Treasurer.*

The Missouri Miner.

The Missouri Miner is a weekly publication and was established in 1914-1915. It records the news of each week of interest to the student body and to the Alumni. It has been adopted as the official organ of the Alumni Association.

The Officers for 1917-1918 are:

F. H. Geib........................*Editor.*
J. P. Gill........................*Associate Editor.*
E. L. Miller........................*Assistant Editor.*
O. Goldsmith........................*Business Manager.*
F. H. Taylor........................*Asst. Business Manager.*
W. Scott........................*Advertising.*
P. D. Wilkinson........................*Assistant Advertising.*
R. K. Stroup........................*Circulation.*

E. R. Housholder........................*Senior Class.*
E. E. Ashlock........................*Junior Class.*
C. B. Hummel........................*Sophomore Class.*
L. R. Short........................*Freshman Class.*

The Alumni Association.

In September, 1915, a move was inaugurated to organize an alumni association. After a preliminary nomination and election of officers, this association came into definite form on October 25, 1915. It has for its purpose the bringing together of the Alumni in closer relation with each other and their Alma Mater. All graduates, ex-students who have spent one year at the school, and present and former members of the faculty, are eligible to membership. Notices of the proceedings of the Association will be published in the Missouri Miner, and it is, therefore, recommended that all members of the Association subscribe for this publication. The Association will from time to time promote the interest of the School and its former students by establishing Alumni Clubs in the various centers. Three of these clubs have already been formed as follows:

Kansas City Alumni Club.

The Alumni of the School of Mines and Metallurgy living in and adjacent to Kansas City met in the banquet room of the Kupper Hotel February 6, 1915, and organized a Kansas City Alumni Club.

The officers for 1917-1918 are:

President......R. R. Benedict, '08, Park Board, Kansas City.
Secretary.......H. W. L. Porth, '11, care of Swift & Co., Packers' Station, Kansas City, Kan.

St. Louis Alumni Club.

Former students and alumni living in and near St. Louis organized a St. Louis Alumni Club January 29, 1916.

President......Kurt V. Moll, 4445 Laclede Ave., St. Louis.
Secretary.......Robert Patrick Cummins, Frisco Bldg., St. Louis.

Joplin Alumni Club.

Former students and alumni of the School living in Joplin and adjacent territory organized the Joplin Alumni Club on December 29, 1915.

President......E. W. Buskett, '95, 620 Joplin street, Joplin.
Secretary.......C. H. O'Neill, 511 N. Ball street, Webb City.

Officers of Alumni Association.

President......W. Rowland Cox, 120 Broadway, New York, N. Y.
Vice-President..Ray F. Rucker, Aluminum Ore Co., East St. Louis, Ill.
Secretary.......Charles Y. Clayton, Rolla, Mo.

Advisory Committee.

George R. Dean..................................Rolla, Mo.
L. E. Garrett....................................Rolla, Mo.
Kurt V. Moll.................4445 Laclede Ave., St. Louis, Mo.
R. R. Benedict, Board of Park Commissioners..Kansas City, Mo.
E. W. Buskett.......................620 Joplin St., Joplin, Mo.
H. T. Mann.......................................Rolla, Mo.

EXPENSES

Tuition Fee.

Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after January 1, 1909, nonresidents of Missouri who matriculate in any Department of the University be required to pay a tuition fee of $20.00 per year."

Laboratory Fees.

The fees charged are as follows: An incidental and library fee of $5.00 a year, payable upon entrance; a laboratory fee in general chemistry to cover the cost of gas and supplies, $10.00 a semester; a laboratory fee in qualitative analysis of $10.00 a semester to cover the cost of general supplies and gas; a laboratory fee for quantitative analysis and Senior and Junior chemistry laboratory work, $2.00 a semester; a fee of $2.50 a semester to cover the cost of supplies for shop work; a fee of $2.50 a semester to cover the cost of fuel and supplies in forge work; a fee of $2.50 a semester to cover supplies in machine shop; a fee of $25.00 a semester to cover the cost of supplies and fuel in the assay laboratory; a fee of $5.00 a semester for metallurgical laboratory; a fee of $4.50 a semester for mineralogy labratory; a fee of $2.50 for diploma; a gymnasium and athletic fee of $5.00 a semester.

Excursion Expenses.

The cost of field excursions will average about $50.00 a year. The total expenses of all trips in the four-year mining curriculum is about $200.00.

Contingent Deposits.

A deposit of $15.00 is required from each student to cover the cost of extra supplies and damage to apparatus. This deposit must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Annual Expenses.

The following is an estimate of the heaviest items of the student's expenses. As personal tastes vary widely, no estimatee of total expenses is offered:

Room rent, nine months, \$5.00 to \$10.00 per month, average	\$65.00
Board, thirty-six weeks, \$4.00 per week, average	144.00
Fees, excluding tuition	55.00
Drawing instruments (first year) and books	25.00

FEES IN MINE ENGINEERING CURRICULUM

FRESHMAN YEAR.

First Semester.

Matriculation	$5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
General Chemistry Laboratory	5.00
Shop Work	2.50
Athletic Fee	5.00

Second Semester.

Tuition (free for Missouri students)	$10.00
General Chemistry Laboratory	5.00
Forge	2.50
Athletic Fee	5.00

SOPHOMORE YEAR.

First Semester.

Matriculation	$5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
Qualitative Analysis Laboratory	10.00
Mineralogy	4.50
Athletic Fee	5.00

Second Semester.

Tuition (free for Missouri students)	$10.00
Quantitative Analysis Laboratory	2.00
Mineralogy	4.50
Athletic Fee	5.00

*This is a deposit to cover extra supplies and breakage. An account is kept with each student and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

JUNIOR YEAR.

First Semester.

Matriculation	$5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
Quantitative Analysis Laboratory	2.00
Athletic Fee	5.00

Second Semester.

Tuition (free for Missouri students)	$10.00
Assaying 2w	25.00
Assaying 2f	18.00
Assaying 4w	10.00
Athletic Fee	5.00

SENIOR YEAR.

First Semester.

Matriculation	$5.00
Contingent Deposit*	15.00
Tuition (free for Missouri students)	10.00
Metallurgy Laboratory	5.00
Athletic Fee	5.00

Second Semester.

Tuition (free for Missouri students)	$10.00
Athletic Fee	5.00
Diploma Fee	2.50

*This is a deposit to cover extra supplies and breakage. An account is kept with each student and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

JACKLING LOAN FUND

Loans may be made to students of the School of Mines from the Jackling Loan Fund under the following conditions:

1. The student must have been in attendance at the School of Mines one semester.

2. Written requests for loans must be filed with the Director to be considered at the following meeting of the Executive Committee.

3. Loans may be made to students who cannot give security, provided they present the endorsement of the Director of the School and a responsible party not connected with the School.

4. No loans of more than one hundred dollars may be made to any one student during the calendar year.

5. The student shall give his note for the amount of the loan, which note shall bear interest at the rate of five per cent per annum from the date of the note to one year after his graduation or his leaving the School of Mines, and for one year following at the rate of eight per cent per annum. The note shall then become due.

The purpose of the Jackling Loan Fund is to help worthy students who require financial assistance and who are unable to borrow money from other sources.

THE MINING EXPERIMENT STATION

Officers of the Station.

ALBERT ROSS HILL, Ph. D., LL. D. . *President of the University.*
AUSTIN LEE MCRAE, S. D. . . . . *Director.*
GUY HENRY COX, Ph. D., E. M. . . . *Geology and Mineralogy.*
CARROLL RALPH FORBES, E. M.* . . . *Mining.*
VICTOR HUGO GOTTSCHALK, Ph. D. . *Chemistry.*
HORACE THARP MANN, E. M. . . . . . . *Metallurgy and Ore Dressing.*
MARTIN HARMON THORNBERRY, B. S. *Research Assistant.*

The Mining Experiment Station was established June 1, 1909.

It is the object of the Station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters; to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and metallurgical engineering to the mineral industry of the State of Missouri.

The following bulletins were issued during the year:

E. S. McCandliss, "Preliminary Report on Blended Portland Cements"; J. C. Ingram, "Studies in the Production of Oils and Tars from Bituminous Materials;" F. D. James, "The Hydrometallurgy and Electrolytic Precipitation of Zinc;" M. H. Thornberry and H. T. Mann, "Addition Agents in Flotation, Part I".

The Experiment Station is now working in co-operation with the State Geological Survey and the National Bureau of Mines on the milling and concentration of Missouri lead and zinc ores.

Any resident of the State may on request obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Correspondence regarding these bulletins or the work of the Station may be addressed to the Director, Mining Experiment Station, Rolla, Missouri.

*Absent on military service.

BUREAU OF GEOLOGY AND MINES

The Geological Survey of the State of Missouri has its headquarters at Rolla, and occupies the Rolla Building on the School campus.

Board of Managers.

GOVERNOR FREDERICK D. GARDNER, Jefferson City,
President.
ELIAS S. GATCH, St. Louis,
Vice-President.
CLARK CRAYCROFT, Joplin,
Secretary.
EDWARD M. SHEPARD, Springfield,
Chairman of Publication Committee.
PHILIP N. MOORE, St. Louis.

Staff of the Geological Survey.

H. A. BUEHLER,
State Geologist.
M. E. WILSON,
Assistant State Geologist.

Equipment and Investigations.

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects, and a museum of seven thousand specimens of clay coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri.

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of geology to the ore deposits is also worked out and detailed reports published concerning such investigations.

The Department has the following reports available for distribution at the present time:

DEGREES CONFERRED IN 1917

COMMENCEMENT EXERCISES MAY 25, 1917.

Engineer of Mines.

Paul Richardson Cook, B. S. 1907.
Van Buren Hinsch, B. S. 1909.
Dibrell Pryor Hynes, B. S. 1908, B. S. 1911.
German Garcia Lozano, B. S. 1911.
Frederick Galloway Moses, B. S. 1914.
Ernest Wander, B. S. 1910.

Metallurgical Engineer.

Cairy C. Conover, B. S. 1912.

Civil Engineer.

Frederick Hauenstein, A. B. (Westminster) 1900, B. S. 1903.
Edgar Scott McCandliss, B. S. Purdue University, 1909.

Master of Science.

John Charavelle Ingram, B. S. 1913.

Chemical Engineer.

John Whittlesey Bodman, B. S. 1910.

Bachelor of Science in Mine Engineering.

Joseph C. Barton.
James Henry Bock, Jr.
John Stafford Brown.
Ralph Dale.
Phillips Brooks Dolman.
Arturo Cleofas Fernandez.
David Greenberg.
William Guest.
Ramsey Coleman Henschel.
Clemence William Hippard.
William Henry Kamp.
John Thomas Keenan.
Yaro Klepel.
Stanislaw Wojciech Lesniak.
Elton Arthur Miller.
James Raymond Nevin.
Paul Frederick Pape.
John Henderson Gay Reilly.
Frederick Pine Shayes.
Earl Joseph Weimer.
John Kennedy Walsh, A. B., St. Louis University, 1914.

Bachelor of Science in Metallurgy.

Harry Atwood Ambler.
Frank Stillman Elfred, Jr.
Howard Andrew Horner.
Floyd Dixie James.
Martin Harmon Thornberry.
Thomas Patrick Francis Walsh.

Bachelor of Science in Civil Engineering.

Frederick Lovett Eames.
Carl Alden Peterson.
John Joshua Shipley.
Ray Otto Shriver.
Howard Jones Teas.
George Baldwin Wilson.

Bachelor of Science in General Science.

Emmett Lee Arnold, A. B., Drury College, 1914.

Bachelor of Science in Mechanical Engineering.

Clarence Elmer Muehlberg.

Bachelor of Science in Electrical Engineering.

Harry Tobias Heimberger.

THESES SUBMITTED IN 1917

The Goltra Process of Concentrating Iron Ores as Developed at Waukon, Iowa. . . . . Ernest Wander.
Concentration of Ores by Flotation. . . . . . J. H. G. Reilly and F. S. Elfred, Jr.
Chemical Control Work in the N. K. Fairbank Factories, J. W. Bodman.
Refineria de Petroleo en Minatitlan. . . . German Garcia Lozano.
Concentration of a Joplin Slime by Flotation, E. J. Weimer and W. H. Freudenberg.
Some Typical Bridges for Logging Railroad Construction, Frederick Hauenstein.
Selective Concentration of a Complex Ore by Flotation, P. F. Pape and Ralph Dale.
Cyaniding the Buckhorn, Arizona, Clay. . . . . Paul R. Cook.
A Preliminary Report on Blended Portland Cement, E. S. McCandliss.
Determination of Earth Pressure on Vertical and Inclined Walls, R. O. Shriver, J. J. Shipley and G. B. Wilson.
A Mine Model Showing Methods of Ventilation. . . . V. B. Hinsch.
Practical Details of Mine Surveying in Certain Mines in Northern Mexico. . . . . A. C. Fernandez.
Relation of Experimental Work to Mill Design and Practice, Dibrell P. Hynes.
Studies on the Production of Oils and Tars from Bituminous Materials. . . . . John C. Ingram.
The Hydrometallurgy and the Electrolytic Precipitation of Zinc, Floyd D. James.
Sample Methods and Tables for Determining True Meridian, H. J. Teas.
Comparative Tests of Hammer Drill Bits. . . . . J. C. Barton.
Leaching an Oxidized Lead Ore with Brine. . . . . F. G. Moses.

STUDENTS, 1917-1918

Graduate Students

Bland, George Vest, B. S., '04 . . . . *Boulder, Colo.*
DeWaters, Roy Hayward, B. S., '09 . . . . *Argo, Ill.*
Finagin, Joseph Cooper, Jr., B. S., '14 . . *Collinsville, Okla.*
Hanley, Herbert Russell, B. S., '01 . . . . . *Kennett, Cal.*
Hogoboom, William Coryell, B. S., '14 . . *Picher, Okla.*
Pierce, Colwell Arba, B. S., '16 . . . . *Patagonia, Ariz.*
Cowperthwaite, Thomas, B. S., '05 . . . . . *Warren, Ariz.*
Hinsch, Van Buren, B. S., '09, E. M.,'17 . *Rolla, Mo.*
Radcliffe, Donald Hewson, B. S. in G. S.,
'13 . . . . *Tulsa, Okla.*

Seniors.

MINE ENGINEERING.

Chavez, Raul . . . . *Chihuahua, Mexico.*
Duga, Joseph Benjamin . . . . *Bellaire, Ohio.*
Geib, Francis Hodgson . . . . *Denver, Colo.*
Hoo, Te Chun . . . . *Hun San, Hunan, China.*
Housholder, Earl Ross . . . . *Bowling Green, Ohio.*
Kluge, Harry Albert . . . . *Collinsville, Ill.*
Maness, Orie, Newell . . . . *Rolla, Mo.*
Reber, William Houston . . . . *Dallas, Tex.*
Scheurer, Leroy Robert . . . . *Rolla, Mo.*
Weimer, Raymond Samuel . . . . *Girard, Kan.*
Zoller, Lawrence Joseph . . . . *Tulsa, Okla.*

METALLURGY.

Clark, Howell Smith . . . . *Kansas City, Mo.*
Doennecke, Henry William . . . . *Davenport, Iowa.*
Golick, Tony Frank . . . . *Canton, Ill.*
Shanfeld, Michael Wayne . . . . *St. Louis, Mo.*
Stahl, Horace Reynolds . . . . *Quincy, Ill.*
Velasco, Rafael Esteba . . . . *San Luis, Potosi,*
S. L. P., Mex.

CIVIL ENGINEERING.

Burkhart, Edgar Carl Moritz . . . . *Macon, Mo.*
Zeuch, Walter Charles . . . . *St. Louis, Mo.*

MECHANICAL ENGINEERING.

Mellow, George Edward.............*St. Louis, Mo.*

GENERAL SCIENCE.

Wilson, Eldred Dewey...............*Rolla, Mo.*

Juniors

MINE ENGINEERING.

Benton, Louis Brent..................*Ft. Worth, Tex.*
Bohart, Philip Harris.................*Ft. Worth, Tex.*
Bruce, Robert, Jr.....................*Wellington, Kan.*
Decker, Ernest Ethridge.............*Tulsa, Okla.*
Dowd, Raymond John................*St. Louis, Mo.*
Eulich, Artileus Vosteen..............*St. Joseph, Mo.*
Flanders, Jerome Emerson...........*Paris, Mo.*
Goldsmith, Osher......................*Dallas, Texas.*
Gotsch, Oscar, Jr.....................*St. Louis, Mo.*
Hurd, Harold Walter.................*Paris, Mo.*
Marston, Robert L...................*El Paso, Tex.*
Miller, Edwin Lawrence..............*Kansas City, Mo.*
Moore, Fred Vail.....................*Crystal City, Mo.*
Morris, John Munson................*Farmington, Mo.*
Morris, Thomas Carson..............*Farmington, Mo.*
Niece, William Latchaw..............*Tulsa, Okla.*
Nolte, William John..................*St. Louis, Mo.*
Ore, Felipe Buenaventura............*Callao, Peru.*
Petsch, Arthur Henry.................*Lexington, Mo.*
Powell, William Clark................*Rolla, Mo.*
Schnaidt, Charles Michael............*St. Louis, Mo.*
Starkey, Alvah Chapman.............*San Diego, Cal.*
Tao, Hung Tao.......................*Chiotung, Yunam, China.*

METALLURGY.

Gill, James Pressley..................*Montgomery City, Mo.*
Hansen, Knud Fabricius.............*Copenhagen, Denmark.*
Scott, James Walter..................*Rolla, Mo.*
Smiley, Vivian X......................*Hannibal, Mo.*
Weiser, Hanley........................*Webster Grove, Mo.*
Wilson, Kenneth Campbell............*Globe, Ariz.*

CIVIL ENGINEERING.

Ashlock, Evan Earl...................*St. Louis, Mo.*
Harris, Harold Shelton...............*Morley, Mo.*
McCarthy, Meryl.....................*Bowling Green, Mo.*
McKinley, Lionel William.............*Willma, Minn.*

CHEMICAL ENGINEERING.

Goldman, Leon Harrison............. *St. Louis, Mo.*
Krause, Frederick Arthur............. *St. Louis, Mo.*
Nichols, Benjamin Guthrie............ *E. St. Louis, Ill.*
Oyler, William Ellsworth............. *Brookfield, Mo.*
Wilkinson, Paul DeLassus............. *St. Louis, Mo.*

MECHANICAL ENGINEERING.

Cole, Joseph Bryant.................. *Rolla, Mo.*
Lottmann, Walter Frederick.......... *St. Louis, Mo.*

Sophomores

MINE ENGINEERING

Bloom, George Barnett............... *Maysville, Mo.*
Cairns, Arthur Lee.................. *Cape Girardeau, Mo.*
Cameron, Campbell Robinson......... *McAlester, Okla.*
Charles, Beryl Elwood............... *Salina, Kan.*
Davidson, Lewis Ely................. *Savannah, Mo.*
Durning, William Clarence........... *St. Louis, Mo.*
Ewing, Harold Kline................. *Odessa, Mo.*
Forgotson, James Morris............. *St. Louis, Mo.*
Hahn, Abner Decker.................. *Muscatine, Iowa.*
Halligan, Charles Francis........... *Union, Mo.*
Hollow, John Edward................. *Cuba, Mo.*
Goodwin, Edward Harold.............. *Baxter Springs, Kan.*
Goodwin, George Gerald.............. *Baxter Springs, Kan.*
Hoppock, Harland Hobart............. *Joplin, Mo.*
Howard, Clifford Peter.............. *Wilburton, Okla.*
Howendobler, John Leslie............ *Tulsa, Okla.*
Hume, Horace Catlett................ *Webb City, Mo.*
Johnston, Irvin Benson.............. *St. Louis, Mo.*
Klyman, Julius Hart................. *St. Louis, Mo.*
Larsh, Napoleon Bonaparte........... *Nebraska City, Neb.*
Mann, Marion Robert................. *Gallatin, Mo.*
Miller, John Gaines................. *Marshall, Mo.*
McMillen, Morris Frank.............. *Branson, Mo.*
Norville, Glen Smith................ *Beardstown, Ill.*
Place, Roscoe Nelvin................ *Gallatin, Mo.*
Pryor, William George............... *Bethany, Mo.*
Rackett, Gerald Franklin............ *Chicago, Ill.*
Richmond, Wendell William........... *Hannibal, Mo.*
Schlesinger, Louis Max.............. *Fredericktown, Mo.*
Scruby, Horace Dwight............... *Chillicothe, Mo.*
Sherman, Benjamin Edward............ *Tahlequah, Okla.*
Shore, Harold Frank................. *Chillicothe, Mo.*

Steffens, Frederick, Jr. . . . . *St. Joseph, Mo.*
Stroup, Robert Knox . . . . *Quincy, Ill.*
Uthoff, Frederick William . . . . *St. Louis, Mo.*
White, Frederick Pope . . . . *E. St. Louis, Ill.*
Whitworth, Virgil Lee . . . . *Nevada, Mo.*
Wright, Kenneth Maurice . . . . *Kansas City, Mo.*

ELECTRICAL ENGINEERING.

Casselman, Lawrence Owen . . . . *Rolla, Mo.*
Elkins, Charles Edgar . . . . *Dixon, Mo.*
Hawkins, Robert Russell . . . . *Crocker, Mo.*
Tutt, Bland Richard . . . . *Crocker, Mo.*

CHEMICAL ENGINEERING

Bash, David Anderson . . . . *Hannibal, Mo.*
Conrad, John DeWitt . . . . *Hamilton, Mo.*
Finlay, William James . . . . *Webster Groves, Mo.*
Gettler, Carl Andrew . . . . *Hannibal, Mo.*
Hodges, Isaac Franklin . . . . *Granby, Mo.*
Howald, Arthur Mark . . . . *Sullivan, Mo.*
Hummel, Carl Bernard . . . . *Kansas City, Mo.*
Kershner, Karl Kenneth . . . . *St. Louis, Mo.*
Laun, Albert Charles . . . . *St. James, Mo.*
Taylor, Frank Huston . . . . *Rolla, Mo.*
Williams, Edgar A . . . . *Withers Mills, Mo.*

METALLURGY.

Bailey, Harold Leland . . . . *Virginia, Ill.*
Dorris, Milburn Lee . . . . *Collinsville, Ill.*
Johnson, Richard Love . . . . *Henryetta, Okla.*
Kroenlien, George Alfred . . . . *St. Louis, Mo.*
Slover, Edwin Allsop . . . . *E. Orange, N. J.*
Stubbs, Robert Newton, Jr . . . . *Kirkwood, Mo.*
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CIVIL ENGINEERING.

Barnard, Charles Russell . . . . *St. Louis, Mo.*
Dunlop, William Harry . . . . *Beardstown, Ill.*
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Zieseniss, Harry Wesley . . . . *Rolla, Mo.*

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GENERAL SCIENCE.

Kerr, Arthur John................... *Rolla, Mo.*
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Ahrens, Herbert Emmet.............. *Corning, Mo.*
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Delaloye, August Francis.............. *Rolla, Mo.*
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Dreidel, Eugene...................... *St. Louis, Mo.*
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Galpin, Havilah Roy................. *Gallatin, Mo.*
Guy, Earl McKinley.................. *Davenport, Iowa.*
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Illidge, Robert Eugene................ *Corbett, Ore.*
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Kerr, Homer Chalmers................ *Rolla, Mo.*
Kosky, John......................... *St. Louis, Mo.*
Lewis, Vernon Bruce................. *Collinsville, Ill.*
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Miller, Roy Ranson.................. *Carl Junction, Mo.*
Montieth, Clarence Doran............. *Springfield, Mo.*
Moore, Robert Douglas............... *Carthage, Mo.*

Mundt, Herbert William. . . . . *St. Louis, Mo.*
Mutz, Herman Jacob. . . . . *Elizabethtown, N. M.*
Needham, Albert Booth. . . . . *Collinsville, Ill.*
Netzeband, William Ferdinand. . . . . *St. Louis, Mo.*
Nevedomsky, Samuel Leonard. . . . . *St. Louis, Mo.*
Nighswonger, Ray Dean. . . . . *Cameron, Mo.*
Norville, Howard Oliver. . . . . *Beardstown, Ill.*
Nudelman, Barney. . . . . *St. Louis, Mo.*
Patterson, Harold Ford. . . . . *Warrensburg, Mo.*
Roe, Kenneth Gordon. . . . . *Marceline, Mo.*
Ross, Cyral Cornelius. . . . . *Rolla, Mo.*
Salmon, Julius Clarence, Jr. . . . . *Rayville, La.*
Scully, Alvin. . . . . *Collinsville, Ill.*
Shanfeld, Samuel Norman. . . . . *St. Louis, Mo.*
Short, Leonard Rutherford. . . . . *St. Louis, Mo.*
Smith, James Alger. . . . . *Steelville, Mo.*
Stevens, Thomas Adren. . . . . *Caney, Kan.*
Stewart, William Lincoln. . . . . *Pittsburgh, Pa.*
Storrs, George Walter. . . . . *Hannibal, Mo.*
Sutherland, Orson Reed. . . . . *Miami, Okla.*
Truax, Myron Whitney. . . . . *Jasper, Mo.*
Tutt, Lawrence Eugene. . . . . *Crocker, Mo.*
Tyrrell, Morris Lee. . . . . *Collinsville, Okla.*
Uthoff, Carl Joseph. . . . . *Oak Park, Ill.*
Wallace, Milton Wardell. . . . . *St. Louis, Mo.*
Webb, Albert Loomis. . . . . *El Paso, Tex.*
Webber, Ivan Emmens. . . . . *Liberal, Mo.*
Wilson, James Mortimer. . . . . *Hannibal, Mo.*
Wilson, Joseph Mortland. . . . . *Rock Rapids, Iowa.*
York, George Wesley. . . . . *Kirksville, Mo.*

Special Students

Adams, William Herbert. . . . . *Rolla, Mo.*
Colville, George, Jr. . . . . *Marceline, Mo.*
Cornwell, Benjamin Sedgely. . . . . *St. Louis, Mo.*
Elias, Zella. . . . . *Rolla, Mo.*
Gatch, Calvin Fletcher. . . . . *St. Louis, Mo.*
Gerber, Clarence Oliver. . . . . *Kansas City, Mo.*
Gerber, Elizabeth Sparks. . . . . *Kansas City, Mo.*
Hawkins, Mabel. . . . . *Rolla, Mo.*
Hurst, Henry William. . . . . *Kansas City, Mo.*
Hynes, Julius Henry. . . . . *St. Louis, Mo.*
Kamp, Henry George. . . . . *St. Louis, Mo.*
Lenox, Jennie Lynn. . . . . *Rolla, Mo.*
Mann, Walter Jay. *Rolla, Mo.*
Millar, Charles James. . . . . *Webb City, Mo.*

McClurken, Russell Craig.............*St. Louis, Mo.*
Owen, Luther Cecil...................*Joplin, Mo.*
Reinoehl, Clyde O....................*Rolla, Mo.*
Sheppard, Dan Carey..................*Kansas City, Mo.*
Tiffy, Ethel Blanche.................*Clinton, Mo.*
Triefenbach, George Louis............*St. Louis, Mo.*
Turner, Basel Harold.................*St. Louis, Mo.*
Via, Jessie..........................*Rolla, Mo.*
Wilson, Marie Lucile.................*Rolla, Mo.*
Windmuller, Philip Alexander.........*St. Louis, Mo.*
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STUDENTS IN MILITARY SERVICE
1916-1917

Ackers, Albert Louis,
U. S. G. S. Geological Surveyor.

Aid, Harry,
Observer, U. S. G. S.

Ambler, Harry Atwood,
1st Lieut. Co. L, 30th Inf.

Anderson, Sidney Lorenzo,
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Arnold, Emmett Lee,
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Badollet, Marion Smith,
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U. S. G. S. Military Work.

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Bowles, Martin Frady,
2nd Lieut. Co. B. 355th Inf.

Brazill, Matthew Patrick, Jr.,
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Carson, William Thomas,
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Cooper, Richard Dwyer,
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Corby, Harry Gilbert,
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Crow, Wayman,
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CUNNINGHAM, LORAINE HARRY,
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CZADERSKI, MAKSYMILIAN JOSEF,

DALE, RALPH,
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DAWSON, THOMAS LANGHEAD,
1st Lieut., Aviation, A. E. F.

DORRIS, CHARLES LESTER,
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EBMEYER, GERARD ERNEST,
3rd Officers Training Camp.

EHLER, OTTO,
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ETEM, CHARLES AUGUST,
Signal Service.

FAST, JOSEPH BERNARD,
Illinois N. G.

FENELON, CHARLES ORVILLE,
Co. E. 10th Bat., 20th Engrs.

FIELDLER, JOHN RAY,
7th Engineers.

FORMAN, PERCY GRANT,
Sergt., Co. C. 364th Inf.

FOX, GEORGE HOWARD,
Cadet Aviation School.

FRAME, FLOYD HILL,
1st Lieut., Ordnance Dept.

GRAY, WILLIAM DOUGLAS.
Corp., 1st Co., 138th Inf.

GREENBERG, DAVID,
Sergt. 11th Co., 164th Depot Brigade.

HALEY, RALPH ALWOOD,
17th Aero Squadron, A. E. F.

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HAYES, STANLEY MENTON,
Sergt. M. G. Co., 354th Inf.

HEIMBERGER, KARL WILLIAM,
2nd Lieut., F. A. A. E. F.

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Sergt. Co. C., 110th Engrs.

HERIVEL, H. T.,
23rd Co., 164th Depot Brigade.

HILL, JAMES CRANE,
128th Inf., Machine Gun Co.

HIPPARD, WESLEY GEORGE,
2nd Lieut., 5th Recruit Training Battalion, 161st Depot Brigade.

HOPPOCK, LEWIS NEEDHAM,
Training Ship, "Kearsarge."

KAHLBAUM, WILLIAM,
19th Co., 159th Depot Brigade.

KAMP, WILLIAM HENRY,
2nd Lieut., Aviation.

KEELER, WILLIAM WEAVER,
U. S. G. S. Topographer.

KEENAN, JOHN THOMAS,
Major, E. O. R. C.

KLEPEL, YARO.
Battery E, 348th F. A.

KLUGE, HARRY ALBERT,
27th Engrs.

LANG, FREDERICK ROBERT,
Aviation School.

LAWRENCE, HIRAM PETTIBONE,
2nd Lieut., 140th Inf.

LEACH, THOMAS WITT,
2nd Lieut., Battery C, 341st F. A.

LUCKY, MAURICE CECIL,
2nd Lieut., Headquarters Co., 59th Depot Brigade.

LYONS, ROBERT PAUL,
Co. 7th, E. O. T. C.

MCCANDLISS, EDGAR SCOTT,
Capt. and Adj., 1st Battalion, 314th Engrs.

MELLOW, RICHARD WESLEY,
2nd Lieut., C. A.

MEYER, JOHN HAROLD,
Q. M. C. A. E. F.

MESLOH, HERBERT GEORGE,
Co. 56th, 164th Depot Brigade.

MILLER, GALEN,
U. S. Naval Training Station.

MUEHLBERG, CLARENCE ELMER,
2nd Lieut., C. A. C.

MURPHY, EARLE NELSON.
1st Lieut., 314th Ammunition Train.

OAKLEAF, LOVELL RANDAL,
Master Engineer Junior Grade,
37th Div. Kan. Engr.

PAGE, JAMES HAROLD,
Topographer, U. S. G. S.

PETERSEN, CARL ALDEN,
2nd Lieut., 165th Depot Brigade.

POPE, FREDERICK ALEXANDER,
2nd Lieut., 336th F. A.

POTTS, ALLEN DEWEY,
23rd Co., G. S. I.

PRAY, DONALD PORTER,
Radio School, U. S. Navy.

PRYOR, GEORGE WILLIS,
Cornetist, 8th Reg. Band.

PUGH, JAMES WILLARD,
1st Lieut., Battery C, 341st F. A.

RAIBLE, JOSEPH CHRISTOPHER,
1st Lieut., Aviation, A. E. F.

REILLY, JOHN HENDERSON GRAY,
2nd Lieut., 13th Cav.

RICE, CARL CLARK,
2nd Lieut., U. S. Inf., A. E. F.

RIDDLESPERGER, RALPH RUDOLPHUS,
Sergt., Co. K., 355th Inf.

SHAYES, FREDERICK PINES,
2nd Lieut., C. A. Aviation School.

SHERWOOD, THEODORE CLAYTON, JR.,
Corp., Co. I, 356th Inf.

SHIPLEY, JOHN JOSHUA,
U. S. Navy, Aviation

SHOTWELL, PHILLIP BASSETT,
Headquarter's Brigade.

SHRIVER, RAY OTTO,
2nd Lieut., 314th Engrs.

SKEEN, LESLIE CARLISLE,
Junior Master Engineer.

SMART, ROBERT JOHN.
Corp., Headquarters Co., 342nd F. A.

SPICKARD, HAROLD EWING,
7th Engrs.

SPRIGG, SIMEON NORWOOD,
2nd Lieut., Battery F., 341st F. A.

STANFIELD, EDWIN R.,
13th Co., C. A. C.

STOKES, LAWRENCE WILLIAM,
Corp., Battery F, 342nd F. A.

STONER, OSCAR ELI,
2nd Lieut., Battery E, 340th F. A.

TEAS, HOWARD.
Co. A., 27th Engrs.

TERRY, MARK LOREN,
2nd Lieut., Battery A., 340th F. A.

TIDD, LUZERNE, MAURICE,
2nd Lieut., Battery C, 341st F. A.

WALSH, JOHN KENNEDY,
2nd Lieut., Headquarters 340th F. A.

Walsh, Thomas Patrick Francis,
2nd Lieut., 16th Co., C. A. C.

Wilson, George Baldwin,
1st Lieut., E. O. R. C.

Wynn, Clarence Marion,
5th Missouri N. G.

STUDENTS IN MILITARY SERVICE
1917-1918

Bailey, Harold Leland,
Cadet, Aviation.

Bloom, George Burnett,
School of Aviation.

Charles, Beryl Elwood,
U. S. G. S., I. C. C.

Clark, Howell Smith,
Ordnance Dept.

Clayton, George Dillard, Jr.,
Cadet Aviation School.

Deckmeyer, Frederick,
Cadet Aviation School.

Doennecke, Henry William,
Ordnance Dept., U. S. Powder Reservation.

Dorris, Milbourne Leo,
Naval Training School.

Duga, Benjamin,
Receiving Barracks No. 2.

Durning, William Clarence,
Private Camp Zachary Taylor.

Elkins, Charles Edgar,
Electrician, Co. I, Q. M. C.

Ewing, Harold Kline,

Flanders, Jerome Emerson,
Naval Training School.

Gatch, Calvin Fletcher,
Corp., Cadet Aviation School.

Goldman, Leon Harrison,
Ordnance Dept.

Golick, Tony Frank,
Ordnance Dept.

LINGSWEILER, JOHN WALLACE,
Naval Training School.

MARSTON, ROBERT L.,
Naval Air Service.

MELLOW, RICHARD W.,
Cadet Aviation School.

RICHMOND, W. W.,
Cadet Aviation School.

SCOTHORN, CARL WILLIAM,
Submarine Electrician, Great Lakes Naval Training School.

SCRUBY, HORACE DWIGHT,
Co. 8, 3rd Reg. U. S. Naval Camp.

SHORT, LEONARD RUTHERFORD,
Royal Flying Corps.

SUTHERLAND, ORSON REED,
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Ordnance Dept., Mo. N. G.

WILLIAMS, ANVIL CLARK,
29th Engrs.

WILSON, KENNETH CAMPBELL,
Cadet, British Flying Service.

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Volume Eleven Number Two

SCHOOL OF MINES

AND

METALLURGY

UNIVERSITY OF MISSOURI

BULLETIN

MARCH, 1919

1918—CATALOGUE—1919

ROLLA, MISSOURI

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SCHOOL OF MINES

AND

METALLURGY

UNIVERSITY OF MISSOURI

FORTY-EIGHTH ANNUAL CATALOGUE

ROLLA, MISSOURI

1919

SOUTH GATE.

CALENDAR FOR 1919-1920

1919

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NOVEMBER

S	M	T	W	T	F	S
–	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	–	–	–	–
–	–	–	–	–	–	–

DECEMBER

S	M	T	W	T	F	S
–	–	–	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	–

ROLLA BUILDING.

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CALENDAR

1919

January 3 and 4, Friday and Saturday	Registration for Winter Term.
January 6, Monday	Class Work Begins.
February 22, Saturday	Washington's Birthday, Holiday.
April 26, Saturday	Commencement Day.
April 28, Monday	Registration for Spring and Summer Term.
July 4, Friday	Independence Day, Holiday.
August 16, Saturday	Spring and Summer Term Closes.
August 29 and 30, Friday and Saturday	Registration for Fall Term.
September 1, Monday	Class Work Begins.
November 27, Thursday	Thanksgiving, Holiday.
December 20, Noon, Saturday	Fall Term Closes.

1920

January 2 and 3, Friday and Saturday	Registration for Winter Term.
January 5, Monday	Class Work Begins.
April 24, Saturday	Commencement Day.
April 26, Monday	Registration for Spring and Summer Term.
August 14, Saturday	Spring and Summer Term Closes.

BOARD OF CURATORS

S. L. Baysinger	*Rolla, Mo.*
H. J. Blanton	*Paris, Mo.*
John H. Bradley	*Kennett, Mo.*
D. R. Francis	*St. Louis, Mo.*
James E. Goodrich	*Kansas City, Mo.*
H. B. McDaniel	*Springfield, Mo.*
G. E. Muns	*Montgomery City, Mo.*
C. B. Rollins	*Columbia, Mo.*
Milton Tootle, Jr.	*St. Joseph, Mo.*

OFFICERS OF THE BOARD

D. R. Francis	*President.*
C. B. Rollins	*Vice-President.*
J. G. Babb	*Secretary.*
R. B. Price	*Treasurer.*

EXECUTIVE COMMITTEE

S. L. Baysinger	*Rolla.*
H. B. McDaniel	*Springfield.*
G. E. Muns	*Montgomery City.*

OFFICERS OF THE COMMITTEE

S. L. Baysinger	*Chairman.*
Edw. Kahlbaum	*Secretary.*
C. M. Knapp	*Treasurer.*

CAMPUS VIEW.

FACULTY

ALBERT ROSS HILL,

President of the University.

A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905; Dalhousie University, 1908; Westminster College, 1909; Washington University, 1915; Lafayette College, 1915; Universities of Colorado and Michigan, 1916; University of California, 1918.

AUSTIN LEE McRAE,

Director and Professor of Physics.

B. S., University of Georgia, 1881; S. D., Harvard University, 1886.

JOSEPH WAYNE BARLEY,

Professor of English and Modern Languages.

A. B., 1897; A. M., 1905; William Jewell College; Ph. D., University of Pennsylvania, 1911.

GUY HENRY COX,

Professor of Geology and Mineralogy.

B. S. in General Science, Northwestern University, 1905; M. A., 1908; Ph. D., University of Wisconsin, 1911; E. M., School of Mines, 1914.

GEORGE REINALD DEAN,

Professor of Mathematics.

C. E., School of Mines, 1890; B. S. in Mathematics and Physics, School of Mines, 1891.

HAROLD SHIELDS DICKERSON,

Professor of Mechanical Engineering.

B. S., University of Michigan, 1905; B. S., Purdue University; M. E., Purdue University, 1911.

CARROLL RALPH FORBES,

Professor of Mining.

B. S., Michigan College of Mines, 1902; E. M., Michigan College of Mines, 1903. On leave fall term, Major, 217th Engineers.

ELMO GOLIGHTLY HARRIS,
Professor of Civil Engineering.
C. E., University of Virginia, 1882.

HAROLD LESLIE WHEELER,
Librarian.
A. B., Brown University, 1910; B. L. S., New York State Library School, 1913.

HERBERT JOSEPH WILD,
Professor of Military Science and Tactics.
C. E., Pennsylvania Military College, 1896; Major, Engineer Corps, U. S. Army.

CHARLES LAURENCE DAKE,
Associate Professor of Geology and Mineralogy.
A. B., 1911; A. M., 1912; University of Wisconsin.

FRANK EDWARD DENNIE,
Associate Professor of Athletics and Physical Director.
B. S. in Civil Engineering, Brown University, 1909. On leave, Capt. Co. C, 314th Engineers, A. E. F.

LEON ELLIS GARRETT,
Associate Professor of Mathematics.
B. S. in General Science, School of Mines, 1901. On leave after March 1, 1919.

HORACE THARP MANN,
Associate Professor of Metallurgy and Ore Dressing, in charge of Metallurgy Department, and secretary of the Faculty.
B. S. in Mining Engineering, School of Mines, 1908; M. S. in General Science, School of Mines, 1909; E. M., School of Mines, 1910.

WILLIAM DeGARMO TURNER,
Associate Professor of Chemistry in charge of the Chemistry Department.
B. S., 1909, Ph. D., 1917, University of Chicago.

HENRY HORTON ARMSBY,
Assistant Professor of Civil Engineering.
B. S., 1911, C. E., 1916, Pennsylvania State College.

JOSEPH HENRY BOWEN,
Assistant Professor of Shop Work and Drawing.
Graduate, Miller School, Virginia. On leave fall term, 1st Lieut. Ordnance Department.

CHARLES YANCEY CLAYTON,
Assistant Professor of Ore Dressing and Metallurgy.
B. S. in Metallurgy, School of Mines, 1913; Met. E., School of Mines, 1916.

FRANCIS POTTER DANIELS,
Assistant Professor of Modern Languages.
A. B., University of Michigan, 1895; A. M., University of Missouri, 1897; Ph. D., University of Missouri, 1905.

HOWARD LEROY DUNLAP,
Assistant Professor of Chemistry.
B. S., Ohio University, 1912; M. A., Ohio State University, 1914.

EUGENE LEE JOHNSON,
Assistant Professor of English.
Ph. B., Emory College, 1899; LL. B., Mercer University, 1902; Ph. B., Chicago University, 1910.

EDGAR SCOTT McCANDLISS,
Assistant Professor of Civil Engineering.
B. S. in Civil Engineering, Purdue University, 1909; C. E., School of Mines, 1917. On leave until March 1, 1919, Capt. and Adj., 1st Battalion, 314th Engineers.

GARRETT A. MUILENBURG,
Assistant Professor of Geology and Mineralogy.
A. B., 1912, M. S., 1913, University of Iowa.

RAYMOND ROLLINS SERMON,
Athletic Director.
Ph. B., Warrensburg (Missouri) State Normal, 1913; B. P. E., Springfield (Massachusetts) Y. M. C. A. College, 1917.

JAMES T. SHUTTLEWORTH,
Assistant Professor of Military Science and Tactics.
2nd Lieutenant, U. S. Army.

WOLDEMAR MARKOVITCH STERNBERG,
Assistant Professor of Chemistry.
Chem. E., Institute of Technology, Petrograd, Russia, 1908; Ph. D., University of Minnesota, 1918.

ROLLAND SCHANEL WALLIS,
Assistant Professor of Civil Engineering.
B. S. in E. E., 1907; B. S. in C. E., 1909; C. E., 1915, Iowa State College.

EDGAR CARL MORITZ BURKHART,
Instructor in Engineering.
B. S., School of Mines, 1918.

JOSEPH BRYANT COLE,
Instructor in Machine Shop.

FLOYD HILL FRAME,
Instructor in Physics and Electricity.
A. B. Clark College, 1912. On leave, Captain, Ordnance Department, A. E. F.

VAN BUREN HINSCH,
Instructor in Mathematics.
B. S., 1909, E. M., 1917, School of Mines.

R. STEWART LILLARD,
Instructor in Civil Engineering.
B. S. in C. E., University of Tennessee, 1916. On leave, 1st Lieut. Engineers, A. E. F.

MARTIN HARMON THORNBERRY,
Research Assistant.
B. S., School of Mines, 1912.

SPECIAL LECTURERS

Howell Smith Clark, B. S.
"Experience in the Ordnance Department."
January 23, 1919.

Major Carroll R. Forbes, E. M.
"Engineering Experiences in the Army."
January 24, 1919.

Dr. J. J. Rutledge, U. S. Bureau of Mines, McAlester, Okla.
"First Aid and Mine Rescue."
January 27, 1919.

Captain E. S. McCandliss, C. E.
"Engineering Work for the St. Mihiel Drive."
February 21, 1919.

Dr. Bailey Willis, Dean of Geology and Mining, Leland Stanford University.
"The Mining Engineer's Job."
February 25, 1919.

Paul R. Cook, E. M.
"Cyanide Practice at San Juancito Honduras, C. A."
February 26, 1919.

Leon Harrison Goldman and Marion Smith Badollet.
"The Manufacture of Poisonous Gases."
February 27, 1919.

Milling, Mining and Smelting of Copper.
U. S. Bureau of Mines Moving Picture Films.
March 19, 1919.

Dr. Max F. Meyer, Professor of Experimental Psychology, University of Missouri.
"The Mysteries of the Soul."
March 21, 1919.

OTHER OFFICERS

ROBERT RICHMOND DICKERSON,
Superintendent of Buildings and Grounds.

EDW. KAHLBAUM,
Registrar.

MARGUERITE IRISH,
Assistant Librarian.

ZELLA ELIAS,
Stenographer.

MABEL HAWKINS ZEUCH,
Stenographer.

STUDENT ASSISTANTS

CHARLES RUSSELL BARNARD,
Student Assistant in Drawing.

JAMES PRESSLEY GILL,
Graduate Student Assistant in Assaying.

†ARTHUR MARK HOWALD,
Student Assistant in Chemistry.

†FREDERICK ARTHUR KRAUSE,
Student Assistant in Chemistry.

*GEORGE ALFRED KROENLEIN,
Student Assistant in Mining.

†WALTER FREDERICK LOTTMAN,
Student Assistant in Mechanical Laboratory.

*First semester.
†Second semester.

JOHN MUNSON MORRIS,
Student Assistant in Surveying.

†THOMAS CARSON MORRIS,
Student Assistant in Mineralogy.

BENJAMIN GUTHRIE NICHOLS,
Student Assistant in Chemistry.

BARNEY NUDELMAN,
Student Assistant in Chemistry.

*GERALD FRANKLIN RACKETT,
Student Assistant in Mineralogy.

†RUDOLPH CHARLES SCHAPPLER,
Student Assistant in Physics.

JAMES WALTER SCOTT,
Student Assistant in Metallurgy.

SAMUEL NORMAN SHANFELD,
Student Assistant in Chemistry.

*JOHN RUSSELL STUBBINS,
Student Assistant in Surveying.

ROBERT NEWTON STUBBS, Jr.,
Student Assistant in English and Modern Language.

RONALD OWEN SWAYZE,
Student Assistant in Gymnasium.

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*First semester.
†Second semester.

FACULTY COMMITTEES, 1918-19

Admission and Advanced Standing.
DEAN, BARLEY, MANN.

Athletics.
COX, SERMON, WALLIS.

Discipline.
COX, ARMSBY, BARLEY, FORBES, MANN.

Military Drill.
SHUTTLEWORTH, ARMSBY, FORBES, MUILENBURG, SERMON.

Publications.
BARLEY, DAKE, WHEELER.

Curricula and Undergraduate Degrees.
DEAN, DAKE, DICKERSON, GARRETT, TURNER.

Theses and Graduate Degrees.
HARRIS, COX, DANIELS, MANN, TURNER.

Schedules.
MANN, DAKE, DUNLAP.

Petitions.
BARLEY, COX, DEAN.

HISTORY OF THE SCHOOL

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

Object of These Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (Laws 1915, Sec. 11134.)

Right to Confer Degrees.—The College of Agriculture and the School of Mines and Metallurgy shall have power to confer degrees suitable to their designs and courses of study; and the School of Mines and Metallurgy shall provide courses for, and shall confer the bachelor of science and professional degrees in mining engineering, in metallurgy, in mechanical engineering, in electrical engineering, in chemical engineering, in civil engineering and the degrees of bachelor and master of science in general science. (Laws 1915, Sec. 11141.)

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The statutes fix the status of the school as one of the Colleges of the State University. Its affairs are under the immediate supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body. The need of general culture as a foundation and accompaniment of specifically technical training led to the establishment, in 1885, of an Academic Course in compliance with the following act of the General Assembly:

"Academic Course of Study, Etc.—That the obligation of the State to the General Government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the University of the State of Missouri shall prescribe

and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of a bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof." (Revised Statutes, 1909, Section 11135.)

ENDOWMENT

The proceeds from the sale of 275,000 acres of public lands granted to Missouri by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent interest. The School of Mines receives one-fourth of the yearly income thus accruing.

"The proceeds of the sale of lands donated to the State of Missouri by the United States for the support of the College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy, by Act of Congress approved July 2, 1862, represented by State certificates of indebtedness, of the following amounts and dates:

July 2, 1883	$242,000.00
November 1, 1883	5,000.00
January 29, 1884	5,000.00
April 19, 1884	35,000.00
April 2, 1885	5,000.00
February 25, 1886	5,000.00
January 1, 1888	5,000.00
December 15, 1888	5,000.00
May 15, 1889	5,000.00
July 1, 1891	5,000.00
May 15, 1893	5,000.00
July 1, 1895	22,881.19
April 9, 1895	5,000.00
Representing a total of	$349,881.19

Now issued or any certificates which may hereafter be issued under any general or special act of the General Assembly; one-fourth of the interest of these funds shall be paid to the Treasurer of the School of Mines and Metallurgy, at Rolla, for the maintenance of said institution."

"The proceeds of sales of lands donated to the School of Mines and Metallurgy, at Rolla, represented by the State certificate of indebtedness of $2,000, dated April 15, 1893, issued under act of March 31, 1883, interest on which shall be applied to the maintenance of the School of Mines and Metallurgy, at Rolla."

"The State certificate of indebtedness of $3,000, issued under act of April 1, 1895, dated April 15, 1896, four-fifths of the interest

to be applied to the maintenance of the State University, at Columbia, and one-fifth to the School of Mines and Metallurgy, at Rolla, and also any other certificate which may hereafter be issued and held in trust for this fund under any general or special act of the General Assembly." (Revised Statutes, 1909, Section 11161.)

In addition to the foregoing, the School of Mines receives one-fourth of the interest on municipal and drainage district bonds amounting to $16,000.00, purchased under authority of Section 11168 of the Revised Statutes of 1909, amended by act approved April 7, 1911, Session Acts, 1911, p. 415.

By an Act of Congress, approved August 30, 1890, commonly known as the "Morrill Bill," the General Government assists each State and Territory in maintaining a college or colleges in accordance with the act of July 2, 1862. After deducting one-sixteenth for the Lincoln Institute, Missouri gives one-fourth of the remainder of this fund to the School of Mines.

"All sums collected under the provisions of an Act of Congress, approved August 30, 1890, commonly known as the 'Morrill Bill,' shall be paid as follows: One-sixteenth thereof for the benefit of the Lincoln Institute and one-fourth of the remainder to the Treasurer of the School of Mines, at Rolla, Missouri." (Revised Statutes, 1909, Section 11171.)

In 1891 the Government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23, and the Thirty-sixth General Assembly of the State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University at Columbia and the School of Mines and Metallurgy at Rolla. One-fifth of the income from this endowment is received by the School of Mines.

"The State certificate of indebtedness of $646,958.23, derived from 'direct tax' received from the United States, dated April 1, 1891, issued under act of March 26, 1891, four-fifths of the interest to be applied for the maintenance of the State University, at Columbia, and one-fifth for the School of Mines and Metallurgy, at Rolla." (Revised Statutes, 1909, Section 11161.)

The Fortieth General Assembly of the State passed an act providing for a tax on collateral inheritances for the benefit of the State University, and the Forty-first General Assembly provided that one-fifth of the funds derived from this tax shall be appropriated for the benefit of the School of Mines.

Collateral Inheritance Tax.—"The moneys received by the State Treasurer under the provisions of this article shall be deposited in the State Treasury to the credit of the fund now existing in the State Treasury and known as the 'State Seminary Moneys' for the maintenance, support and better equipment of the

buildings, apparatus, books, instruction, etc., of the University of the State of Missouri, to an amount not exceeding in any one year the equivalent of one-tenth of one mill for every dollar of the assessed valuation of taxable property of the State for the said year: *Provided*, that one-fifth of all such moneys so received shall be devoted to the use of the School of Mines and Metallurgy, a department of the said University." (Revised Statutes, 1909, Section 312.)

LOCATION

The School of Mines is located at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco Railroad, approximately halfway between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above the sea level, and has an agreeable and notably healthful climate. Its position on the great transcontinental railway system makes it readily accessible.

The school is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of mining geology, mining methods, ore dressing, and mining machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores, have given the school advantages for the application of the theories of geology, mining, and ore dressing to practice.

The smelting industry of the State is very important, and every courtesy is extended to the professors and students of the school during their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay-working and cement plants in St. Louis and vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also various chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are over twenty-seven acres in extent. The campus contains beautiful lawns, groves of native oak, and maple shade trees.

The Jackling Field has a good baseball diamond, a football gridiron, tennis courts, and a 440-yard running track.

The new gymnasium is conveniently situated at the east end of the athletic field and is equipped with lockers, shower baths, dressing rooms, swimming pool and the usual gymnastic apparatus.

BUILDINGS

Rolla Building.

This building was originally built by the City of Rolla as a High School building, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, including a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey, toilet, shower baths, and locker rooms.

Chemical Hall.

The main portion of this building was erected in 1885 and two wings were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five feet by sixty feet and one story high. A stock room twenty-eight feet wide by forty-four feet long, two stories high, was erected in 1915, and is accessible to the qualitative and quantitative laboratories. This entire building, including a large basement, is used for chemistry.

Power Plant.

This building, erected in 1895, is a tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, an instrument room, and laboratories—the other comprising an engine room, a boiler room, and a mechanical engineering laboratory.

Mechanical Hall.

This two-story brick building, erected in 1901, is one hundred fifty feet by sixty feet and was specially designed for mechanical work. The second floor includes a demonstration lecture room and a shop for bench work in wood. The first floor contains a lathe room for wood turning, a forge room, a metal-working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers, and an office for the instructor.

Norwood Hall.

The corner stone of this building was laid November 23, 1902, and the building was first used in 1903. It contains adequate quarters for lecture and recitation rooms for physics, geology, mineralogy, civil engineering, English, mathematics; also drawing rooms and laboratories for physics, geology, mineralogy, civil engineering and mechanical engineering.

Ore Dressing Building.

This is a three-story gray press-brick building with a basement and two large one-story wings. Two stories and the west wing have been in use since January, 1908, and the east wing was erected in 1909. The building provides quarters for metallurgy and ore dressing. The building was completed in 1911 and contains over twenty-five thousand square feet of floor space.

Parker Hall.

This is a fire-proof, two-story gray press-brick building, with a well-lighted basement. The main portion of the building is one hundred two by fifty-five feet and the wing is fifty-eight by sixty feet. The library occupies the second story of the building; the administrative offices, faculty room, and board room are located on the first floor; and the assembly room is in the two-story wing. In the basement are the testing machines and the cement laboratories. This building was erected in 1912.

The Gymnasium.

This building, which was completed in 1915, was made possible by the appropriation of seventy thousand dollars by the Forty-seventh General Assembly. The Gymnasium is located at the north end of the campus, in a portion of Main street which was vacated by the city of Rolla for the purpose. The front is to the south, and the west side opens onto Jackling Field.

The building occupies a space seventy-two feet wide and one hundred twenty-seven feet long, and is finished in dark red, rough brick with gray terra-cotta trimmings. The interior is of fire-proof construction, with concrete and composition floors, except in the gymnasium proper, which is floored with maple. Tile partitions are used throughout the building, and the roof is concrete, supported by steel trusses and covered with asbestos roofing.

On the ground floor, entered by the main entrance on the south of the building, are the cloakrooms, locker rooms, training quarters and visiting teams' room, shower baths and swimming pool. The

swimming pool is twenty by sixty feet, finished in white enamel and equipped with all modern appliances. The water supplied to the pool is circulated with a small motor-driven pump, and a constant temperature is maintained by passing the water through a special steam boiler.

The mezzanine floor is on a level with Jackling Athletic Field, and opens upon a terrace which parallels the running track. On this floor are committee rooms, general toilet rooms, the auxiliary gymnasium and balcony overhanging the swimming pool. On the second floor is the gymnasium room proper. This room is seventy feet wide by ninety feet long and is well equipped. On this floor also is the examination room, office and reception room.

The gallery of the gymnasium is a running track, with twenty-six laps to the mile. At the south end of the building on the third floor is a large lounging and rest room.

Carpenter Shop.

The general repair work of the school and construction of laboratory equipment is carried on in a frame building, one hundred fifty feet by twenty-two feet. This building is located west of Mechanical Hall, and includes a store room for lumber.

LIBRARY

HAROLD L. WHEELER, Librarian; MISS IRISH, MR. GETTLER, MR. NORVILLE.

The library occupies the second floor of Parker Hall. Its quarters consist of a large, well-lighted reading room, a stack room equipped with a double-neck Snead stack, capacity 45,000 volumes, and a suite of offices and workrooms for the library staff. All equipment is new and up-to-date, meeting in every way the needs of the library and its clientele.

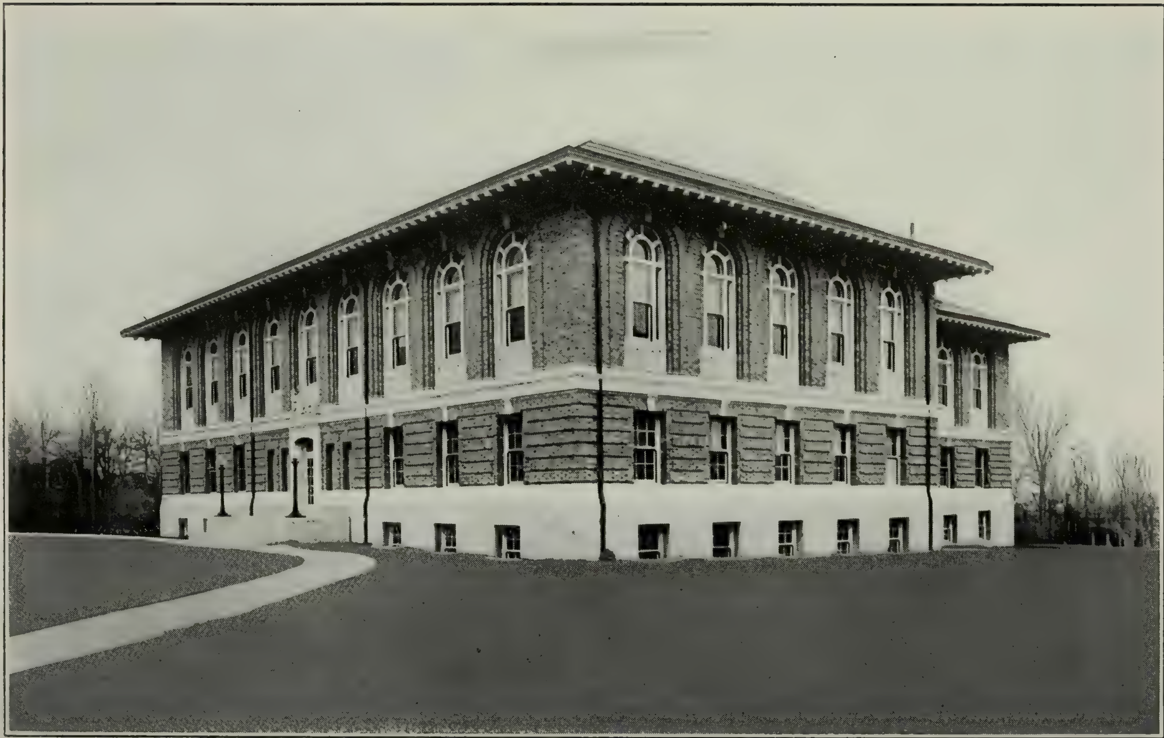
The collection of books numbers more than 20,000 carefully selected volumes, together with a large collection of pamphlets, bulletins and reports of mining companies. The library has one of the most complete files in the middle West of American and foreign technical journals and the proceedings of scientific and engineering societies. These resources are constantly increased with reference to the different courses of study, while at the same time there is kept in view the development of a well-rounded general library. The bulk of the collection consists of works in the sciences, chiefly geology, physics, chemistry, and the useful arts, the main part of this division being engineering and mining treatises. Besides these collections, the library has the representative works in American and English literature, some fiction, a good section of biography, and the latest books of description and travel, the latter division being kept especially strong, so that the students may be informed concerning the manners and customs of the people and the characteristics of the countries into which they are likely to go to follow their vocation.

The library is a subscriber to the standard technical periodicals and the publications and transactions of societies and congresses. The leading general magazines are taken for recreational reading. The contents of the back files of this material is made available through the general periodical indexes, the engineering and mining indexes, and other bibliographic aids.

The Dewey decimal system of classification is used and the resources of the collection are made available through a full dictionary catalogue of authors, titles, and subjects.

Interlibrary loan arrangements exist between this library and the Library of Congress, the St. Louis Public Library, John Crerar

NORWOOD HALL.



PARKER HALL.

Library of Chicago, and the University Library at Columbia. By this arrangement books not in the collection at the School of Mines may be borrowed for the use of the students for a limited time.

The reading room is open daily from 7:45 to 12; 1 to 6, and 7 to 10; Sunday 2 to 5. Books and periodicals may be borrowed by all officers and students of the school, and by others having permission.

ADMISSION

Under the statutes, persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good, liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman class at entrance was about eighteen years. Specific requirements have been fixed by consideration of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries.

Students are admitted in the following ways:

By Certificate:

Applicants who are graduates from fully accredited high schools will be admitted without examination, provided they present a certificate signed by the superintendent or principal showing that the applicant has to his credit fifteen units. Of these units three in English, one and one-half in Algebra, one in Plane Geometry are required.

Graduates of fully accredited high schools who lack credit in the required units must pass an examination to make up such deficiency.

Graduates of partially accredited high schools must pass examination in all of the units in which they are deficient.

By Examination:

Applicants who are not graduates of approved high schools are required to pass examinations in fifteen units as outlined below, a unit being equivalent to a year's work in one subject as given in approved high schools. Conditions may be allowed in two of the fifteen units, but these must be removed within one year from the date of entrance.

Applicants from accredited high schools who are not graduates will not be permitted to enter if they receive conditions in any subject or subjects unless a year or more has elapsed since they attended the high school.

By Advanced Standing:

Applicants may be admitted to advanced standing either upon examination in the subjects of the previous year or years or upon certificate from another institution of work accomplished which, in the estimation of the faculty, is equivalent to that completed here by the class into which entrance is sought. They must also before becoming candidates for degrees present evidence of the satisfactory completion of all entrance requirements into the Freshman class. Every applicant must also present a letter of honorable dismissal from the school last attended. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the students within one semester after entrance.

As Special Students:

Special students may be admitted without passing the entrance examination under the following provisions:

1. They must be at least twenty-one years of age.
2. They must show good reasons for not taking a regular course.
3. They must pass such examinations or other tests as shall demonstrate their fitness to pursue profitably all the subjects selected by them.
4. They shall not be candidates for a degree.
5. Special students are expected to do particularly good work in the subjects which they choose. If at any period of the session their work becomes unsatisfactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature, they will be required to take at the same time as much classroom work as the faculty may designate for each particular class.

Definition of Entrance Units.

ENGLISH. (4 units.)

The four units that may be offered in English include grammar, composition and rhetoric, and literature.

The candidate will be required to show a reasonable proficiency in the principles of English grammar, including sentence-analysis. He will be required to show the ability to express himself coherently and correctly, with a fair mastery of the forms of writing, spelling and punctuation, sentence and paragraph structure. He will be examined on the literature listed below, and, if he desires four units, will be required to show also a knowledge of the history of English literature.

The classics prescribed are as follows

1915—1919.

For Reading.

Group I.—Classics in Translation. Two to be Selected—The Old Testament, comprising at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings, and Daniel, together with the books of Ruth and Esther; Homer's Odyssey, with the omission, if desired, of Books I, II, III, IV, V, XV, XVI, XVII; Homer's Iliad, with the omission, if desired, of Books XI, XIII, XIV, XV, XVII, XXI; Virgil's Aeneid. The Odyssey, Iliad, and Aeneid should be read in English translations of recognized literary excellence. For any selection from this group a selection from any other group may be substituted.

Group II.—Shakespeare. Two to be Selected.—Shakespeare's Midsummer-Night's Dream; Merchant of Venice; As You Like It; Twelfth Night; The Tempest; Romeo and Juliet; King John; Richard II; Richard III; Henry V; Coriolanus; Julius Cæsar; Macbeth; Hamlet.

N. B.—The last three only, if not chosen for study.

Group III.—Prose Fiction. Two to be Selected.—Malory's Morte d'Arthur (about 100 pages); Bunyan's Pilgrim's Progress, Part I; Swift's Gulliver's Travels (Voyages to Lilliput and to Brobdingnag); Defoe's Robinson Crusoe, Part I; Goldsmith's Vicar of Wakefield; Frances Burney's Evelina; Scott's Novels, any one; Jane Austen's Novels, any one; *either* Maria Edgeworth's Castle Rackrent, *or* The Absentee; Dicken's Novels, any one; Thackeray's Novels, any one; George Eliot's Novels, any one; Mrs. Gaskell's Cranford; *either* Kingsley's Westward Ho! *or* Hereward the Wake; Reade's The Cloister and the Hearth; Blackmore's Lorna Doone; Hughes' Tom Brown's Schooldays; *either* Stevenson's Treasure Island, Kidnapped, or The Master of Ballantrae, Cooper's Novels, any one; Poe's Selected Tales; *either* Hawthorne's The House of the Seven Gables, *or* Twice Told Tales, *or* Mosses from an Old Manse; A collection of short stories by various standard writers.

Group IV.—Essays, Biography, Etc. Two to be Selected.—*Either* the Sir Roger de Coverley Papers, *or* Selections from The Tatler and The Spectator (about 200 pages); Boswell's Selections from the Life of Johnson (about 200 pages); Franklin's Autobiography; *either* Irving's Selections from the Sketch Book (about 200 pages), *or* The Life of Goldsmith; Southey's Life of Nelson; Lamb's Selections from the Essays of Elia (about 100 pages); Lockhart's Selections from the Life of Scott (about 200 pages); Thackeray's Lectures on Swift, Addison and Steele in the English Humorists; Macaulay: one of the following essays: Lord Clive, Warren Hastings, Milton, Addison, Goldsmith,

Frederic the Great, *or* Madame d'Arblay; Trevelyan's Selections from Life of Macaulay (about 200 pages); *either* Ruskin's Sesame and Lilies, *or* Selections (about 150 pages); Dana's Two Years Before the Mast; Lincoln's Selections, including at least the two Inaugurals, the Speeches in Independence Hall and at Gettysburg, the Last Public Address, *and* Letter to Horace Greeley, together with a brief memoir or estimate of Lincoln; Parkman's The Oregon Trail; Thoreau's Walden; Lowell's Selected Essays (about 150 pages); Holmes' The Autocrat of the Breakfast Table; Stevenson's Inland Voyage, *and* Travels with a Donkey; Huxley's Autobiography *and* selections from Lay Sermons, including the addresses on Improving Natural Knowledge, A Liberal Education, *and* A Piece of Chalk; A collection of Essays by Bacon, Lamb, DeQuincey, Hazlitt, Emerson, and later writers; A collection of Letters by various standard writers.

Group V.—Poetry. Two to be Selected.—Palgrave's Golden Treasury (First Series): Books II and III, with special attention to Dryden, Collins, Gray, Cowper, and Burns; Palgrave's Golden Treasury (First Series): Book IV, with special attention to Wordsworth, Keats, and Shelley (if not chosen for study); Goldsmith's The Traveller, and The Deserted Village; Pope's The Rape of the Lock; A Collection of English and Scottish Ballads, as for example, some Robin Hood ballads, The Battle of Otterburn, King Estmere, Young Beichan, Bewick and Grahame, Sir Patrick Spens, and a selection from later ballads; Coleridge's The Ancient Mariner, Cristabel, and Kubla Khan; Byron's Childe Harold, Canto III or IV, and The Prisoner of Chillon; either Scott's The Lady of the Lake or Marmion; Macaulay's The Lays of Ancient Rome, The Battle of Naseby, The Armada, Irvy; either Tennyson's The Princess, or Gareth and Lynette, Lancelot and Elaine, and The Passing of Arthur; Browning's Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Home Thoughts from Abroad, Home Thoughts from the Sea, Incidents of the French Camp, Herve Riel, Pheidippides, My Last Duchess, Up at a Villa—Down in the City, The Italian in England, The Patriot, "De Gustibus—." The Pied Piper, Istans Tyrannus; Arnold's Sohrab and Rustum, and The Forsaken Merman; Selections from American Poetry, with special attention to Poe, Lowell, Longfellow, and Whittier.

For Study.

Group I.—Drama. One to be Selected.—Shakespeare's Julius Cæsar, Macbeth, Hamlet.

Group II.—Poetry. One to be Selected.—Milton's L'Allegro, Il Penseroso, and either Comus or Lycidas; Tennyson's The Coming of Arthur, The Holy Grail, and the Passing of Arthur;

The selections from Wordsworth, Keats, and Shelley in Book IV of Palgrave's Golden Treasury (First Series).

Group III.—Oratory. One to be Selected.—Burke's Speech on Conciliation with America; Macaulay's Two Speeches on Copyright, and Lincoln's Speech at Cooper Union; Washington's Farewell Address, and Webster's First Bunker Hill Oration.

Group IV.—Essays. One to be Selected.—Carlyle's Essay on Burns, with a selection from Burns' Poems; Macaulay's Life of Johnson; Emerson's Essay on Manners.

MATHEMATICS. (4 Units.)

The four units which may be offered in mathematics are as follows:

Algebra. (1½ Units.) Elementary algebra, including the elementary operations, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and coefficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomial theorem for positive integral exponent, ratio and proportion, and logarithms.

While the study of these particular subjects is recommended, it is not expected that the student shall be able to pass an examination on each and every one of them.

Plane Geometry. (1 Unit.) The work in plane geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of algebra to geometry, and of geometry to algebra and arithmetic.

Solid Geometry. (1½ Unit.) The same recommendations apply here as in plane geometry.

Trigonometry. (1 Unit.) It is to be understood at the outset that this work will not be accepted for advanced standing. This branch of mathematics is of such great importance to the practical engineer that the whole subject must be reviewed and the student led to a point of view which it is impossible to attain in a high school course.

HISTORY.

Four units may be offered in history; one each in Ancient History, Medieval and Modern History, English History, and American History.

CIVIL GOVERNMENT.

One-half unit may be offered in Civil Government. This is the equivalent of one-half year's work in the fourth year of a high school, and the applicant should have a knowledge of the chief organs of local, state, and national government and a knowledge of the historical development of the government.

Physiography.

A student may offer one unit in physiography. A description of this unit will be sent on request.

PHYSICS.

The two units that may be offered in physics are as follows:

1. A year's work, five periods per week, of which at least two must be double periods in individual laboratory work. At least thirty-five exercises, selected from a list of sixty or more, equivalent to those recommended by the National Educational Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory notebooks must be presented by those who are required to take the entrance examination.

DRAWING.

Two units may be offered.

MANUAL TRAINING.

Two units in manual training may be offered. One unit should be in Bench Work and one in Mechanical Drawing. The time required in each of these subjects is five double periods for one year or five single periods for two years. Where conditions permit it is generally advisable to give these subjects as parallel courses.

LATIN.

The four units that may be offered in Latin are as follows:

1. Collar and Daniel's First Latin Book, or the equivalent.

2. Three books of Cæsar's Gallic War with composition based thereon in Moulton and Collar's Preparatory Latin Composition or in Daniel's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romæ, Nepos, or Eutropius may be offered.

3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.

4. Ovid's Metamorphoses (2,000 lines) and four books of Virgil's Aeneid, with prosody.

GREEK.

Three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten Orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman's Parallel Exercises based on Lysias.

GERMAN, FRENCH, SPANISH.

Three units may be offered in German, French, or Spanish. A description of the units will be sent on request. These units will not be accepted for advanced standing.

CHEMISTRY.

The two units that may be offered in chemistry are as follows:

1. A year's work in chemistry, five periods per week, of which at least two must comprise laboratory work.

2. A second year's work in the subject, five periods per week, of which at least two must be laboratory work.

Notebooks showing work done must be presented by those who are required to take the entrance examinations.

These courses will be accepted for admission, but not for advanced standing.

BOOKKEEPING.

One unit may be offered.

COMMERCIAL GEOGRAPHY.

One-half unit may be offered.

Following is a list of schools whose courses have been approved by the University and whose diplomas will admit to the Freshman class without examination.

ACCREDITED SCHOOLS IN MISSOURI*

FULLY ACCREDITED SCHOOLS

Academy of the Visitation (St. Louis.)
Adrian High School
Albany High School
Anderson High School
Appleton City High School
Armstrong High School
Ash Grove High School
Aurora High School
Ava High School
Belton High School
Bethany High School
Bevier High School
Billings High School
Bloomfield High School
Bolivar High School
Bonne Terre High School
Boonville High School
Bosworth High School
Bowling Green High School
Braymer High School
Breckenridge High School
Brookfield High School
Brunswick High School
Buffalo High School
Bunceton High School
Burlington Junction High School
Butler High School
Cainesville High School
California High School
Cameron High School
Campbell High School
Cape Girardeau High School
Carrollton High School
Carterville High School
Carthage High School
Caruthersville High School
Centralia High School
Charleston High School
Chillicothe High School
Clarence High School
Clayton High School
Clinton High School
Cole Camp High School
Columbia High School
Craig High School
Dearborn High School
De LaSalle Academy (Kansas City)
Desloge High School
DeSoto High School
Dexter High School
Doniphan High School
East Prairie High School
Edgerton High School
Edina High School
Eldon High School
Eldorado Springs High School
Elsberry High School
Eolia High School
Everton High School
Excelsior Springs High School
Fairfax High School
Farmington High School
Fayette High School

*Certificates will be accepted from high schools in other states which are affiliated with their respective State Universities provided these are of similar rank with the University of Missouri.

Ferguson High School
Festus High School
Flat River High School
Fredericktown High School
Fulton High School
Gallatin High School
Garden City High School
Gilman City High School
Glasgow High School
Golden City High School
Gorin High School
Grant City High School
Green City High School
Greenfield High School
Greenville High School
Hale High School
Hamilton High School
Hannibal High School
Hardin High School
Harrisonville High School
Hayti High School
Higbee High School
Higginsville High School
Holden High School
Hopkins High School
Hosmer Hall (St. Louis)
Houston High School
Huntsville High School
Iberia Academy (Iberia)
Independence High School
Ironton High School
Jackson High School
Jamesport High School
Jasper High School
Jefferson City High School
Joplin High School
Kahoka High School
Kansas City Central High School
Kansas City Manual Training High School
Kansas City Northeast High School
Kansas City Westport High School
Kemper Military School (Boonville)
Kennett High School
Kendrick Catholic Boys' High School (St. Louis)
Keytesville High School
Kidder Institute (Kidder)
Kirksville High School
Kirkwood High School
Knobnoster High School
Knox City High School
LaBelle High School
Laclede High School
Lamar High School
Lancaster High School
LaPlata High School
Lebanon High School
Lees Summit High School
Lenox Hall (St. Louis)
Lexington High School
Liberty High School
Lockwood High School
Loretto Academy (Kansas City)
Louisiana High School
Macon High School
Maitland High School
Malden High School
Maplewood High School
Marceline High School
Marionville High School
Marshall High School
Marshfield High School
Mary Institute (St. Louis)
Maryville High School
Maysville High School
Meadville High School
Memphis High School
Mexico High School
Milan High School
Moberly High School
Monett High School
Monroe City High School
Montgomery City High School
Mound City High School
Mountain Grove High School
Mt. Vernon High School
Neosho High School
Nevada High School
New Franklin High School

New Hampton High School
New Haven High School
New London High School
Norborne High School
Oak Grove High School
Odessa High School
Oregon High School
Osceola High School
Otterville High School
Ozark High School
Palmyra High School
Paris High School
Pattonsburg High School
Perry High School
Perryville High School
Piedmont High School
Peirce City High School
Platte City High School
Plattsburg High School
Pleasant Hill High School
Polo High School
Poplar Bluff High School
Potosi High School
Princeton High School
Principia, The (St. Louis)
Republic High School
Rich Hill High School
Richmond High School
Ridgeway High School
Rockport High School
Rolla High School
Rosati-Kain High School (St. Louis)
St. Charles High School
Ste. Genevieve High School
St. James High School
St. Joseph Benton High School
St. Joseph Central High School
St. Joseph's Academy (St. Louis)
St. Louis Central High School
St. Louis Cleveland High School
St. Louis McKinley High School
St. Louis Soldan High School
St. Louis Yeatman High School
St. Teresa's Academy (Kansas City)
St. Vincent's Academy (Kansas City)
Salem High School
Salisbury High School
Sarcoxie High School
Savannah High School
Sedalia High School
Seymour High School
Shelbina High School
Shelbyville High School
Sikeston High School
Skidmore High School
Slater High School
Smith Academy (St. Louis)
Smithville High School
Springfield High School
Stanberry High School
Steelville High School
Sturgeon High School
Sullivan High School
Sweet Springs High School
Tarkio High School
Tipton High School
Trenton High School
Troy High School
Union High School
Unionville High School
Vandalia High School
Versailles High School
Walnut Grove High School
Warrensburg High School
Warsaw High School
Washington High School
Webb City High School
Webster Groves High School
Wellston High School
Wellsville High School
Wentworth Military Academy (Lexington)
Weston High School
West Plains High School
Will Mayfield Academy (Marble Hill)
Willow Springs High School
Windsor High School
Wyaconda Consolidated High School

CURRICULA

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged for the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The curricula are the same in the Freshman year and differ but slightly in the Sophomore year. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

One hour is given to each recitation or lecture period. The afternoon periods are given to drawing, laboratory, and field work, and are of three hours' duration; one laboratory period of three hours is rated as equivalent to one and one-half credits.

The School of Mines and Metallurgy offers the following curricula:

I. Mine Engineering, leading to the degree of Bachelor of Science in Mine Engineering. This is a general course in Mine Engineering, having in view all the operations in connection with mining from the prospecting to the delivery of the finished product on the market.

II. Metallurgy, leading to the degree of Bachelor of Science in Metallurgy. This curriculum contemplates especially processes in Metallurgy subsequent to the delivery of ore above ground.

III. Civil Engineering, leading to the degree of Bachelor of Science in Civil Engineering. This is a curriculum in engineering as applied especially to railways, highways, and municipal works.

IV. General Science, leading to the degree of Bachelor of Science in General Science. This curriculum is largely elective and provides for a liberal education in science.

V. Mechanical Engineering, leading to the degree of Bachelor of Science in Mechanical Engineering. This curriculum applies especially to mechanical engineering in shops, mills, ore dressing plants and power plants.

VI. Electrical Engineering, leading to the degree of Bachelor of Science in Electrical Engineering. This is a general course in electrical engineering fitting a man for positions in power plants, transmission plants, central stations and electric railways. The curriculum is so arranged that electives may be chosen in electrochemistry and electro-metallurgy thus fitting a man for the position of electrical engineer in chemical works and metallurgical plants.

VII. Chemical Engineering, leading to the degree of Bachelor of Science in Chemical Engineering. This curriculum is intended for those who desire to fit themselves for the management of industrial plants in which a knowledge of the principles and methods of chemical analysis and the fundamentals of engineering are required.

VIII. Graduate curriculum in Mine Engineering, leading to the degree of Engineer of Mines. The curriculum is open to Bachelors of Science in Mine Engineering.

IX. Graduate Curriculum in Metallurgy, leading to the degree of Metallurgical Engineer. This curriculum is open to Bachelors of Science in Metallurgy.

GRADUATE COURSES

The School of Mines offers graduate work in Mining Engineering, Metallurgy, Ore Dressing, Geology, Economic Geology, Petrography, and Advanced Chemistry. The attention of graduates of engineering schools and of mining schools is directed to the following courses:

Mine Management
Mining Machinery
Mining Machinery Laboratory
Mining Law
Mine Examination and Reports
Mine Plant
Mine Plant Design
Mine Power Plant
Mining Economics
Economic Geology
Geology of the United States
Structural and Metamorphic Geology
Petrography
Petrography Laboratory
Cement and Concrete Structures
Compressed Air
Compressed Air Laboratory
Engineering Designs
Ore Dressing Laboratory
Ore Dressing Problems
Ore Supply
Metallurgy Organization
Metallography
Constitution of Alloys
Metallurgical Problems
Metallurgical Plant
Metallurgical Plant Design
Cyaniding
Electro-Metallurgy
Electro-Metallurgy Laboratory
Metallurgical Research
Electro-Chemistry
Water Analysis
Physical Chemistry
Theoretical Chemistry
Advanced Physico-Chemical Laboratory
Internal Combustion Engines

Graduates from the four-year curriculum in Mining Engineering may pursue graduate work leading to the degree of Engineer of Mines. Electives may be chosen along any line approved by the Faculty.

A similar graduate curriculum is offered in Metallurgy. This leads to the degree of Metallurgical Engineer.

SPECIAL COURSES

In addition to the regular curricula leading to degrees, before mentioned, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying, and Electricity.* They have been planned for the benefit of those who for various legitimate reasons are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* requires two years' work, although mature students, who have already some knowledge of chemistry, may complete it in one year.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draftsmen. The essentials of it are a thorough knowledge of algebra, trigonometry, surveying, field practice, and drawing. One school year and the first term of a second year will be required for the completion of this course.

A short course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides mathematics this course includes general chemistry, assaying, mineralogy, mining, surveying and English.

A course in *Electricity* is offered to furnish the student with the theory of electricity and acquaint him with its application in the arts. This subject is of great importance to every engineer, especially to the mining engineer, since electricity has become such an important factor in mining operations.

DEGREES

I. The degree of Bachelor of Science in Mine Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum I., and all of the required trips of Curriculum I. The final year's work must be done in residence.

II. The degree of Bachelor of Science in Metallurgy will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum II., and all of the trips required in Curriculum II. The final year's work must be done in residence.

III. The degree of Bachelor of Science in Civil Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum III. The final year's work must be done in residence.

IV. The degree of Bachelor of Science in General Science will be conferred upon a candidate who has completed the prescribed work of Curriculum IV. Candidates for degrees in General Science must matriculate in General Science Curriculum not later than the beginning of the second semester of the sophomore year. The final year's work must be done in residence.

V. The degree of Bachelor of Science in Mechanical Engineering will be conferred upon a candidate who has completed the prescribed work of Curriculum V. The final year's work must be done in residence.

VI. The degree of Bachelor of Science in Electrical Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum VI. The final year's work must be done in residence.

VII. The degree of Bachelor of Science in Chemical Engineering will be conferred upon a candidate for a degree who has completed the prescribed work of Curriculum VII. The final year's work must be done in residence.

VIII. The degree of Engineer of Mines, Metallurgical Engineer, will be conferred upon a candidate who holds a degree of Bachelor of Science in Mine Engineering or Bachelor of Science in Metallurgy, respectively, and who has completed, in residence, one year of post-graduate work.

IX. The degree of Engineer of Mines, Metallurgical Engineer, Civil Engineer, Mechanical Engineer, Electrical Engineer, or Chemical Engineer will be conferred upon a candidate who holds a degree of Bachelor of Science in Mine Engineering, Bachelor of Science in Metallurgy, Bachelor of Science in Civil Engineering,

Bachelor of Science in Mechanical Engineering, Bachelor of Science in Electrical Engineering, or Bachelor of Science in Chemical Engineering who has had professional experience in a responsible position for not less than three years. A satisfactory thesis recording the result of some original investigation or independent research in a subject connected with his work, accompanied by such drawings as may be necessary to illustrate it, is required of each candidate for an advanced degree.

A candidate for a professional degree is required to submit list of companies for whom he has worked, with the positions held, the kind of work done, and the length of service.

When a candidate's professional work has been along another line than that in which he received his college training, he may receive the professional degree in that line after five years of practice and by complying with the foregoing statements concerning detailed report of employment and thesis. This applies only to graduates in I., II., III., V., VI., and VII.

Only one professional degree will be allowed for work done *in absentia.*

X. The degree of Master of Science will be conferred upon graduates who have completed a year's graduate work in residence and demonstrated ability by research work and a thesis. Each candidate who is not a graduate of this institution in Curriculum IV. must satisfy the language requirements of Curriculum IV., in addition to completing the graduate requirements. A candidate who is not giving his entire time to graduate study will be unable to earn the degree in one year's residence.

THESES

Seniors may elect, subject to the approval of the head of the Department, to carry on special investigations embodying the results of their work in a thesis. The subject of the thesis must be reported to the Thesis Committee of the Faculty and approved not later than January tenth. The completed thesis must be filed with the Director not later than April fifteenth.

The finished thesis should be typewritten (or printed) on eight and one-half by eleven-inch paper, written on one side only. The paper should be strong linen, unruled and without marginal lines.

The thesis should be typewritten so as to have a margin all around of not less than one and one-half inches.

Thesis paper should not be punched with holes for staples.

Thesis, when submitted, should not be stapled, sewed, or bound in any manner, but should be on loose sheets, in order that all theses may be bound uniformly by the Library.

Drawings, tracings, blue prints, diagrams, statistical tables, etc., when on a single 8½x11 inch sheet, should allow a margin of at least 1½ inches on the inner (long) edge, for binding purposes. When on a larger sheet, requiring folding, large margin should be allowed on all sides, and drawings should not be folded but submitted flat or rolled, in order that they may be properly folded and adjusted by the binder. It is suggested that students confer with the Librarian in regard to the preparation of drawings, diagrams, tracings, etc.

The thesis should have:

(1) A title page containing the subject of the thesis, the writer's name, and the date. It should show the approval of the professor under whose direction the work has been done and should also state the degree for which the candidate is an applicant.

(2) A table of contents.

(3 A list of illustrations.

(4) The body of the thesis, including illustrations.

(5) A bibliography.

(6) An index.

(7) Original drawings or tracings.

All thesis submitted by candidates for degrees become the property of the School of Mines and Metallurgy and may not be published without its approval.

CURRICULUM

Instruction now runs forty-eight weeks during the year, three terms of sixteen weeks each. The curriculum is based on the fall and winter terms. For the present some fall and winter term subjects will be given in the summer term, fall term subjects being given during the first eight weeks and winter term subjects during the second eight weeks. The student will take half as many subjects but will take them twice as intensively. For example, English is given three times a week during the fall and winter terms; it will be given six times a week during the summer term.

Beginning September 1, 1919, the Freshman class will take curriculum on page 44.

First Year for All Curricula.

For Freshmen entering September, 1919.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
Fall Term.						
Chemistry	1, 2	General Chemistry	2	2	6	2
Civil Engineering	2	Plane Surveying	1	1	6	1
English	1f	Rhetoric and Composition	....	3	....	3
Mathematics	1f	College Algebra	....	3	....	3
Mathematics	3f	Plane Trigonometry	....	2	....	2
Mechanical Engineering	2f	Mechanical Drawing	....	....	6	....
Military	1, 2	Military Science and Tactics	1	....	2	....
Physical Education	....	....	....	....	2	....
Winter Term.						
Chemistry	1, 2	General Chemistry	2	2	3	2
English	1w	Rhetoric and Composition	....	3	....	3
Mathematics	5w	Spherical Trigonometry	....	2	....	2
Mathematics	7w	Analytic Geometry	....	3	....	3
Mechanical Engineering	1w	Descriptive Geometry	1	....	3	1
Mechanical Engineering	2w	Mechanical Drawing	....	....	3	....
Mechanical Engineering or Civil Engineering	4w 4	Forge and Machine Shop Topographic Surveying	....	....	6	....
Military	3, 4	Military Science and Tactics	1	....	2	....
Mining	1	Economics of Engineering	....	2	....	2
Physical Education	....	....	....	....	2	....

Second, third and fourth years will be announced in September.

I. MINE ENGINEERING CURRICULUM.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit.
SOPHOMORE YEAR.						
Fall Term.						
Chemistry	6f	Quantitative Analysis	60	....	6	3
Civil Engineering	2f	Plane Surveying	72	....	6	3
English	3f	English Prose	80	3	....	3
Mathematics	9f	Differential Calculus	94			
Mathematics	11f	Integral Calculus	94	4	....	4
Mechanical Engineering	14f	Forge	105	....	3	1½
Physics	1f	General Physics	135	3	....	3
Physics	2f	Physics Laboratory	135	....	3	1½
Military Drill	......	......	124	....	3	1
Winter Term.						
Chemistry	6w	Quantitative Laboratory	60	....	6	3
English	3w	English Prose	81	2	....	2
Geology and Mineralogy	1w	Mineralogy	85	....	9	4½
Mathematics	11w	Integral Calculus	94			
Mathematics	13w	Differential Equations	94	4	....	4
Mechanics	17w	Mechanics	97	4	....	4
Physics	3w	General Physics	136	3	....	3
Physics	4w	Physics Laboratory	136	....	3	1½
Military Drill	......	......	124	....	3	1
JUNIOR YEAR.						
Fall Term.						
Chemistry	6f	Quantitative Laboratory	60	....	6	3
Civil Engineering	7f	Railroad Surveying	73	1	3	2½
Geology and Mineralogy	3f	General Geology	86	3	....	3
Mechanics	19f	Mechanics of Materials	97	4	....	4
Metallurgy	1f	Fire Assaying	110	2	....	2
Metallurgy	2f	Assaying Laboratory	111	....	6	3
Mining	3f	Mining	129	3	....	3
Mining	16f	Mining Laboratory	131	....	3	1½
Winter Term.						
Geology and Mineralogy	3w	General Geology	86	3	....	3
Geology and Mineralogy	4w	Geology Laboratory	86	....	6	3
Geology and Mineralogy	5w	Lithology	87	1	3	2
Mechanical Engineering	5w	Boilers and Engines	102	3	....	3
Mechanical Engineering	8w	Mechanical Laboratory	103	....	6	3
Metallurgy and Ore Dressing	39w	General Metallurgy	120	3	....	3
Mining	5w	Mine Surveying	129	2	....	2
Mining	6w	Mine Surveying Laboratory	129	....	3	1½

I. MINE ENGINEERING CURRICULUM.—*Continued.*

Department.	No.	Course.	Page.	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit.
SENIOR YEAR.						
Fall Term.						
Geology and Mineralogy	9f	Economic Geology	87	4	....	4
Metallurgy and Ore Dressing	5f	Metallurgy	112	4	....	4
Metallurgy and Ore Dressing	6f	Metallurgy Laboratory	114	....	3	1½
Metallurgy and Ore Dressing	33f	Ore Dressing	118	3	....	3
Physics and E. E	7f	Principles of E. E	136	3	....	3
Physics and E. E	8f	Dynamo Laboratory	137	....	3	1½
Electives	....	....	....	....	....	4
Winter Term.						
Geology and Mineralogy	9w	Economic Geology	88			
or						
Metallurgy and Ore Dressing	5w	Metallurgy	114	4		4
Metallurgy and Ore Dressing	33w	Ore Dressing	119	4	....	4
Metallurgy and Ore Dressing	36w	Ore Dressing Laboratory	119	....	6	3
Mining	11w	Mining	130	3	....	3
Mining	19w	Economics and Contracts	131	2	....	2
Physics and E. E	7w	Principles of E. E	136	3	....	3
Physics and E. E	8w	Dynamo Laboratory	137	....	3	1½
Electives	....	....	....	....	....	1½

Between the Junior and Senior year students in Curriculum I must take the Junior Trip, Mining 38.

Electives must be selected from the following courses: Civil Engineering 9f; English and Modern Language 17f, 17w, 19f; Mechanical Engineering 3f, 9f, 11f, 18w; Metallurgy and Ore Dressing 13f, 41w.

Those who wish to specialize in coal mining may omit Metallurgy and Economic Geology and take Mine Ventilation and Power Plants as required courses, and may have fuel analysis added to the list of electives.

Those who wish to specialize in Geology may omit Metallurgy, Principles of Electrical Engineering, and Dynamo Laboratory, and take Field Geology and Structural Geology as required courses and may have Geology of the United States, Oil and Gas, Geology Conference and Petrography added to the list of electives.

II. METALLURGY CURRICULUM.

Sophomore year, either Curriculum I or Curriculum VII.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
JUNIOR YEAR.						
Fall Term.						
Chemistry	6f	Quantitative Laboratory	60	....	6	3
Chemistry	35f	Physical Chemistry	66	3	....	3
Chemistry	36f	Physical Chemistry	66	....	6	3
Geology and Mineralogy	3f	General Geology	86			
or				3	....	3
Chemistry	15f	Eng. Chemistry	61			
Mathematics	19f	Mechanics of Materials	97	4	....	4
Physics and E. E	7f	Principles of E. E	136	3	....	3
or Civil Engineering	7f	Railroad Surveying	73	1	3	2½
or Physics and E. E	8f	Dynamo Laboratory	137	....	5	2½
Winter Term.						
Chemistry	25w	Electrochemistry	64	2	....	2
Chemistry	26w	Electrochemistry	65	....	6	3
Metallurgy and Ore Dressing	1w	Assaying	110	2	....	2
Metallurgy and Ore Dressing	2w	Assaying Laboratory	111	....	9	4½
Metallurgy and Ore Dressing	41w	Iron and Steel	121	3	....	3
Metallurgy and Ore Dressing	39w	General Metallurgy	120	3	....	3
Metallurgy and Ore Dressing	40w	General Metallurgy	121	....	3	1½
Physics and E. E	7w	Principles of E. E	136	3	....	3

Between the Junior and Senior years, students in Curriculum II must take the Junior Trip, Metallurgy 38.

SENIOR YEAR.—Fourteen lectures and fifteen laboratory hours each term, Metallurgy and Ore Dressing 5f, 5w, 6f, 33f, and 33w, and the Senior Trip must be included. All electives must be approved by the Department of Metallurgy.

III. CIVIL ENGINEERING CURRICULUM.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
SOPHOMORE YEAR.						
Fall Term.						
Civil Engineering	1f	Plane Surveying	70	2	...	2
Civil Engineering	4f	Plane Surveying	71	...	9	4½
English	3f	English Prose	80	3	....	3
Modern Languages	9f	Advanced German	82			
Modern Languages	13f	Advanced French	83	3	...	3
Modern Languages	17f	Advanced Spanish	83			
Mathematics	9f	Differential Calculus	94	4	....	4
Mathematics	11f	Integral Calculus	94			
Physics	1f	General Physics	135	3	....	3
Physics	2f	Physics Laboratory	135	....	3	1½
Military Drill	......	......		....	3	1
Winter Term.						
Civil Engineering	4w	Advanced Surveying	72	....	6	3
Civil Engineering	6w	Civil Engineering Drawing	72	....	3	1½
English	3w	English Prose	81	2	....	2
Modern Languages	9w	Advanced German	83			
Modern Languages	13w	Advanced French	83	2	....	2
Modern Languages	17w	Advanced Spanish	83			
Mathematics	11w	Integral Calculus	94	4	....	4
Mathematics	13w	Differential Equations	94			
Mathematics	17w	Mechanics	97	4	....	4
Physics	3w	General Physics	136	3	....	3
Physics	4w	Physics Laboratory	136	....	3	1½
Military Drill	......	......		....	3	0

III. CIVIL ENGINEERING CURRICULUM.—*Continued.*

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
JUNIOR YEAR.						
Fall Term.						
Civil Engineering	7f	Railroad Surveying	73	1	3	2½
Civil Engineering	8f	Railroad Surveying	73	....	3	1½
Civil Engineering	9f	Hydraulics	73	3	3	4½
Civil Engineering	11f	Masonry Construction	74	3	....	3
Civil Engineering	20f	Materials Laboratory	75	....	6	3
Geology and Mineralogy	2f	Mineralogy	85	....	3	1½
Geology and Mineralogy	19f	General Geology	90	1	....	1
Mathematics	19f	Mechanics of Materials	97	4	....	4
Winter Term.						
Civil Engineering	7w	Railroad Surveying	73	1	3	2½
Civil Engineering	11w	Reinforced Concrete	74	3	...	3
Civil Engineering	13w	Roads and Pavements	74	3	....	3
Civil Engineering	15w	Stresses	75	2	6	5
Civil Engineering	23w	Railroad Economics	77	2	....	2
Geology and Mineralogy	21w	General Geology	90	2	....	2
Geology and Mineralogy	22w	Geology Laboratory	91	....	6	3
SENIOR YEAR.						
Fall Term.						
Civil Engineering	15f	Framed Structures	75	3	6	6
Civil Engineering	19f	Water Supply	75	3	....	3
Civil Engineering	31f	Masonry Design	77	3	6	6
		Electives	....	....	...	6
Winter Term.						
Civil Engineering	32w	Designing	78	....	9	4½
Civil Engineering	29w	Sanitary Engineering	77	3	....	3
Civil Engineering	33w	Municipal Economics	78	3	...	3
Civil Engineering	17w	Contracts	75	2	....	2
		Electives	....	....	....	8½

Electives must be selected from the following courses: Topographic Reconnaissances, Irrigation, Mining, Mine Surveying, Metallurgy of Iron and Steel, Principles of Electrical Engineering, Dynamo Laboratory, Engineering Writing, City Planning, Landscape Engineering, Compressed Air, Boilers and Engines.

IV. GENERAL SCIENCE CURRICULUM.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
SOPHOMORE YEAR.						
Fall Term.						
English	3f	English Prose	80	3	....	3
Modern Languages	9f	Advanced German, or	82			
Modern Languages	13f	Advanced French	83	3	....	3
Mathematics	9f	Differential Calculus	94			
Mathematics	11f	Integral Calculus	94	4	....	4
Physics	1f	General Physics	135	3	....	3
Physics	2f	Physics Laboratory	135	....	3	1½
Military Drill	......	......	124		3	1
Elective	......	......				5½
Winter Term.						
English	3w	English Prose	81	2	....	2
Modern Languages	9w	Advanced German or	83			
Modern Languages	13w	Advanced French	83	2	....	2
Physics	3w	General Physics	136	3	....	3
Physics	4w	Physics Laboratory	136	....	3	1½
		Electives	....	....	....	13½
Military Drill	......	......	124	....	3	1
JUNIOR YEAR.						
Fall Term.						
English	5f	Shakespeare	81	3	....	3
		Electives	....	....	....	18
Winter Term.						
English	5w	Contemporary Drama	81	3	....	3
		Electives	....	....	....	18

Senior Year, 21 Electives each term.

In making up his electives in Curriculum IV, the student must select a major field and a minor field. In the former, he is required to complete 50 credit hours and in the latter 25 credit hours. Twelve hours are freely elective.

The student shall choose his major and minor at the beginning of the second term of the Sophomore Year, and his schedule must be approved by the heads of the departments in whose fields he proposes to study.

V. MECHANICAL ENGINEERING CURRICULUM.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
SOPHOMORE YEAR.						
Fall Term.						
Civil Engineering	2f	Plane Surveying	72	....	6	3
English	3f	English Prose	80	3	....	3
Mathematics	9f	Differential Calculus	94			
Mathematics	11f	Integral Calculus	94	4	....	4
Mechanical Engineering	18f	Machine Shop	106	....	3	1½
Mechanical Engineering	14f	Forge	105	....	3	1½
Physics	1f	General Physics	135	3	....	3
Physics	2f	Physics Laboratory	135	....	3	1½
		Elective	....	....	....	3
Military Drill	......	......	124	....	3	1
Winter Term.						
Chemistry	34w	Fuel Analysis	66	....	3	1½
English	3w	English Prose	81	2	....	2
Mathematics	11w	Integral Calculus	94			
Mathematics	13w	Differential Equations	94	4	....	4
Mechanical Engineering	18w	Machine Shop	106	....	6	3
Mechanics	17w	Mechanics	97	4	....	4
Physics	3w	General Physics	136	3	....	3
Physics	4w	Physics Laboratory	136	....	3	1½
		Elective	....	....	....	2
Military Drill	......	......	124	....	3	1

V. MECHANICAL ENGINEERING CURRICULUM.—*Continued.*

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit
JUNIOR YEAR.						
Fall Term.						
Civil Engineering	9f	Hydraulics	73	3	3	4½
Mechanics	19f	Mechanics of Materials	94	4	....	4
Mechanical Engineering	3f	Mechanism	102	3	....	3
Mechanical Engineering	5f	Boilers and Engines	102	3	....	3
Mechanical Engineering	20f	Machine Design	106	....	6	3
		Electives	....	....	....	4
Winter Term.						
Civil Engineering	20w	Materials Laboratory	76	....	3	1½
Mechanical Engineering	7w	Valve Gears	103	2	....	2
Mechanical Engineering	8w	Mechanical Laboratory	103	....	6	3
Mechanical Engineering	9w	Thermodynamics	104	3	....	3
Mechanical Engineering	20w	Engine Design	107	....	6	3
Metallurgy and Ore Dressing	41w	Metallurgy of Iron and Steel	121	3	....	3
		Electives	....	....	....	5
SENIOR YEAR.						
Fall Team.						
Mechanical Engineering	9f	Power Plants	103	3	3	4½
Mechanical Engineering	24f	Power Plant Design	107	....	6	3
Physics and E. E	7f	Principles of E. E	136	3	....	3
Physics and E. E	8f	Dynamo Laboratory	137	....	3	1½
		Electives	....	....	....	9
Winter Term.						
Mechanical Engineering	19w	Industrial Engineering	106	3	....	3
Civil Engineering	17w	Contracts	75	2	....	2
Physics and E. E	7w	Principles of E. E	136	3	....	3
Physics and E. E	8w	Dynamo Laboratory	137	....	3	1½
		Electives	....	....	....	11½

Compressed Air, Internal Combustion, Engines, Heating and Ventilating, Refrigeration, Ore Dressing, Alloys, and Metallography, and Engineering Writing may be chosen as electives.

VI. ELECTRICAL ENGINEERING CURRICULUM.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
SOPHOMORE YEAR.						
Fall Term.						
Civil Engineering	2f	Plane Surveying	72	....	6	3
English	3f	English Prose	80	3	....	3
Mathematics	9f	Differential Calculus }	94			
Mathematics	11f	Integral Calculus }	94	4	....	4
Mechanical Engineering	18f	Machine Shop	106	....	3	1½
Mechanical Engineering	14f	Forge	105	....	3	1½
Physics	1f	General Physics	135	3	....	3
Physics	2f	Physics Laboratory	135	....	3	1½
		Elective	....	....	....	3
Military Drill	......	......	124	....	3	1
Winter Term.						
Chemistry	34w	Fuel Analysis	66	....	3	1½
English	3w	English Prose	81	2	....	2
Mathematics	11w	Integral Calculus }	94			
Mathematics	13w	Differential Equations }	94	4	....	4
Mechanics	17w	Mechanics	97	4	....	4
Mechanical Engineering	18w	Machine Shop	106	....	6	3
Physics	3w	General Physics	136	3	....	3
Physics	4w	Physics Laboratory	136	....	3	1½
		Elective	....	....	....	2
Military Drill	......	......	124	....	3	1

VI. ELECTRICAL ENGINEERING CURRICULUM.—*Continued.*

Department.	No.	Course.	Page	Hrs. per week. Lect.	Lab.	Hours credit.
JUNIOR YEAR.						
Fall Term.						
Civil Engineering	9f	Hydraulics	73	3	3	4½
Mathematics	19f	Mechanics of Materials	97	4	....	4
Physics and E. E	7f	Principles of E. E	136	3	....	3
Physics and E. E	8f	Dynamo Laboratory	137	....	3	1½
Mechanical Engineering	3f	Mechanism	102	3	....	3
Mechanical Engineering	5f	Boilers and Engines	102	3	....	3
Mechanical Engineering	22f	Machine Design	107	....	3	1½
Winter Term.						
Civil Engineering	20w	Materials Laboratory	75	....	3	1½
Mechanical Engineering	6w	Steam Laboratory	103	....	3	1½
Mechanical Engineering	9w	Thermodynamics	104	3	....	3
Metallurgy and Ore Dressing	41w	Metallurgy of Iron and Steel	121	3	....	3
Physics and E. E	7w	Principles of E. E	136	3	....	3
Physics and E. E	8w	Dynamo Laboratory	137	....	3	1½
Physics and E. E	10w	Electrical Laboratory	137	....	6	3
		Electives	....	....	....	5
SENIOR YEAR.						
Fall Term.						
Mechanical Engineering	9f	Power Plants	103	3	3	4½
Physics and E. E	11f	Electrical Machinery	137	2	3	3½
Physics and E. E	13f	Alternating Currents	138	5	....	5
		Electives	....	....	....	8
Winter Term.						
Mining Engineering	19w	Economics and Contracts	130	2	....	2
	11w	Electrical Machinery	137	2	3	3½
Physics and E. E	13w	Alternating Currents	138	5	....	5
Physics and E. E	19w	Electrical Distribution	139	3	....	3
		Electives	....	....	....	7½

Electric Railways, Electro-Metallurgy, Electro-Chemistry, Electrical Transmission and Power Engineering, Engineering Writing and advanced Modern Languages may be chosen as electives.

VII. CHEMICAL ENGINEERING CURRICULUM.

Department.	No.	Course.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
SOPHOMORE YEAR.						
Fall Term.						
Chemistry	31f	Analytical Chemistry	65	2	....	2
Chemistry	32f, 32w	Analytical Laboratory	65	....	12	6
English	3f	English Prose	80	3	....	3
Mathematics	9f	Differential Calculus	94			
Mathematics	11f	Integral Calculus	94	4	....	4
Physics	1f	General Physics	135	3	....	3
Physics	2f	Physics Laboratory	135	....	3	1½
Military Drill	....	Military Drill	124	....	3	1
Mechanical Engineering	14f	Forge	105	....	3	1½
Winter Term.						
Chemistry	21f	Organic Chemistry	63	3	....	3
Chemistry	22f	Organic Chemistry	63	....	9	4½
English	3w	English Prose	81	2	....	2
Mathematics	11w	Integral Calculus	94			
Mathematics	13w	Differential Equations	94	4	....	4
Mechanics	17w	Mechanics	97	4	....	4
Physics	3w	General Physics	136	3	....	3
Physics	4w	Physics Laboratory	136	....	3	1½
Military Drill	....	....	124	....	3	1

VII. CHEMICAL ENGINEERING CURRICULUM.—*Continued.*

Department.	No.	Courses.	Page	Hrs. per week. Lect.	Hrs. per week. Lab.	Hours credit
JUNIOR YEAR.						
Fall Term.						
Chemistry	35f	Physical Chemistry	66	3	...	3
Chemistry	36f	Physical Chemistry	66	....	6	3
Chemistry	123f	Organic Chemistry	67	3	....	3
Chemistry	124f	Organic Chemistry	68	....	6	3
Geology and Mineralogy	2f	Mineralogy	85	....	3	1½
Geology and Mineralogy	19f	Engineering Geology	90	1	....	1
Mechanics	19f	Mechanics of Materials	97	4	....	4
Mechanical Engineering	5f	Boilers and Engines	102	3	....	3
Winter Term.						
Chemistry	17w	Industrial Chemistry	61	3	....	3
Chemistry	18w	Industrial Chemistry	62	....	6	3
Chemistry	23w	Industrial Economics	64	3	....	3
Chemistry	25w	Electrochemistry	64	2	....	2
Chemistry	26w	Electrochemistry	65	...	6	3
Mechanical Engineering	6w	Steam Laboratory	103	...	3	1½
Metallurgy and Ore Dressing	1w	Assaying	110	2	....	2
Metallurgy and Ore Dressing	2w	Assay Laboratory	111	....	3	1½
Metallurgy and Ore Dressing	39w	General Metallurgy	120	3	....	3

Between the Junior and Senior years, students in Curriculum VII must take the Junior Trip Chemistry 38.

VII. CHEMICAL ENGINEERING CURRICULUM.—*Continued.*

Senior Year.

Required Chemistry 17w, 18w.

Electives, 37 credit hours, should be chosen so that about half of the work is in the Departments of Chemistry and of Metallurgy, and the schedule must be approved by the Chemistry Department.

VIII. GRADUATE CURRICULUM IN MINE ENGINEERING.

Graduates of this or other institutions of equal rank who have received the degree of Bachelor of Science in Mine Engineering may matriculate for a course of graduate study and research in Mine Engineering. The minimum requirement is the completion of forty semester hours including a thesis.

Candidates for degrees must give half their time to work upon a major subject which must be in the Department of Mining Geology, or Metallurgy and Ore Dressing. At least one-fourth of the work must be done in one of the other departments noted above. The major and the minor subjects must be approved by the Faculty before the student enters upon the work. A suitable thesis subject must be approved.

IX. GRADUATE CURRICULUM IN METALLURGY.

Graduates of this school or of other institutions of equal rank who have completed a course of study leading to the degree of Bachelor of Science in Metallurgy may undertake advanced work leading to the degree of Metallurgical Engineer. The minimum requirement is forty semester hours including a thesis.

Candidates for the degree of Metallurgical Engineer must give half their time to work upon a major subject in the Department of Metallurgy and Ore Dressing. At least ten units' work shall be upon a minor subject in another department. The major, the minor, and the thesis subjects must be approved by the Faculty.

CHEMISTRY

Associate Professor Turner, Assistant Professors Dunlap and Sternberg, Mr. Nichols, Mr. Krause, Mr. Howald, Mr. Nudelman, Mr. Shanfeld, Mr. Lane.

Equipment.

Our entire building is devoted to chemistry. The main chemical lecture room occupies the entire south wing of the building. The laboratories for general chemistry, qualitative analysis, and organic chemistry on the first floor of the main building, accommodate together about one hundred sixty students. The quantitative laboratories on the second floor have desk room for seventy-five students working at one time. In the north wing is a smaller lecture room, as well as a capacious laboratory for industrial chemistry and a small commercial analytical laboratory.

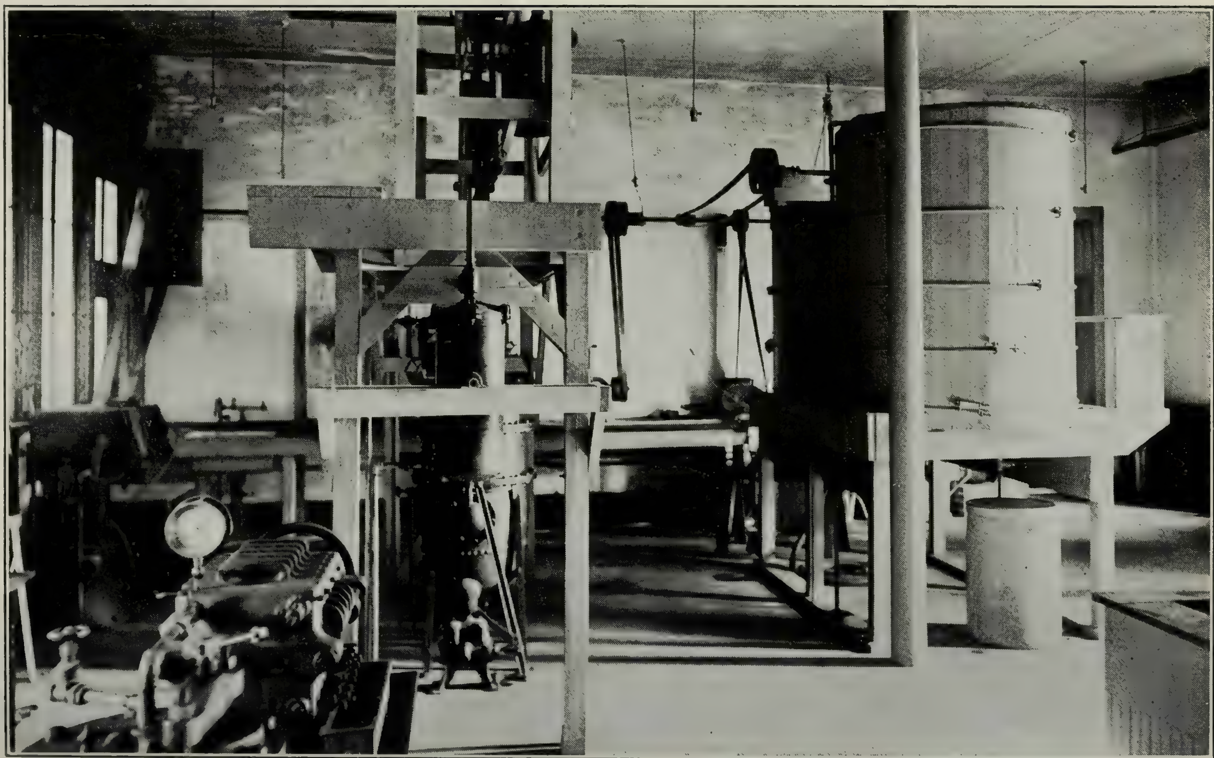
Excellent ventilation is provided by a thirteen-horsepower motor and suction fan connected with individual hoods over each laboratory desk and with the long lines of fume chambers distributed throughout the building. Gas, water, and air blast are supplied conveniently, while a steam-heated still of five gallons an hour capacity furnishes ample distilled water.

The equipment includes twenty-four first-class analytical balances, sixty sets of good analytical weights, sixty sets of volumetric instruments with Bureau of Standards stamps, several complete sets of gas analysis apparatus, standard instruments for the physical and chemical testing of petroleum and its products, a liberal supply of platinum ware, and a good selection of precision instruments for physico-chemical and electro-chemical measurements.

The department has secured the co-operation of some of the chemical manufacturing concerns and is preparing for exhibition a Museum of Industrial Chemistry. Exhibits of the raw material and products illustrating the processes in many of the industries have already been received and are being arranged for display.

An Industrial Laboratory with adequate machinery and accessories is being installed in the north wing of the Chemical Building. The machines installed include a vacuum pan, steam kettles, mixing machines, filter presses, apparatus for distillation and rectification, grinding machinery, and the incidentals necessary for the prepa-

CHEMISTRY BUILDING.



INDUSTRIAL CHEMISTRY LABORATORY.

ration of commercial chemicals, soap, paints, wood products, acids, oils, etc.

With the proposed rearrangement of the building more space will be available for laboratory work in organic, physical, and electro-chemistry, as well as in the applied chemistry.

Courses.

1f. GENERAL CHEMISTRY. *Lectures.* (Dunlap)

This course is a comprehensive study of the general principles of chemistry and of the more important non-metals. The fundamental laws of chemistry are developed in logical order, special attention being given to their application in practical computations. Carefully designed lecture experiments are a feature of the course. The class is divided into several smaller sections for recitation and discussion of problems.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, four hours per week. Credit four hours.

Text: Alexander Smith, *General Chemistry for Colleges.*
Smith & Moore, *Chemical Calculations.*

3w. GENERAL CHEMISTRY. *Lectures.* (Dunlap)

Continuation of course 1f; devoted to the chemistry of the metals, with special consideration of the reactions employed in analytical chemistry, in metallurgy, and in geology. The ionic theory, phase rule, and mass-law are introduced and applied at advantageous points in the lectures.

The course concludes with a series of lectures on elementary applied chemistry.

Prerequisites: Chemistry 1f and 2f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, second term, two hours per week. Credit two hours.

Text: Same as in 1f.

2f. GENERAL CHEMISTRY. *Laboratory.*

(Dunlap, Shanfeld and Nudelman)

The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

Prerequisite: Must be accompanied by Chemistry 1f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, six hours per week. Credit three hours.

Text: *Mimeograph Notes.*
Alexander Smith, *Laboratory Manual of General Chemistry.*

4w. GENERAL CHEMISTRY. *Laboratory.*

(Dunlap, Shanfeld and Nudelman)

This is a continuation of 2f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, second term, three hours per week. Credit 1½ hours.

Texts: Same as for 2f.

NOTE.—Beginning with September, 1919, the general chemistry courses will be scheduled as follows:

The first term, two lectures, two recitations, and two afternoons laboratory per week.

The second term, two lectures, two recitations, and one afternoon laboratory per week.

6w. QUANTITATIVE ANALYSIS. *Laboratory.*

(Sternberg, Howald)

Technical methods for the determination of copper, lead, zinc, arsenic, antimony, sulphur, and coal analysis. Essential parts of the course are the speed tests, in which students are required to report correct results on a number of copper, zinc, and lead ores within a stated time.

Actual ores, analyzed by the instructing staff, are on hand in quantity, and the students are trained to attain the same degree of accuracy which obtains in smelter laboratories.

Prerequisite: Chemistry 6w.

Required in I., and II.

Junior year, first term, six hours per week. Credit three hours.

Text: Low, *Ore Analysis.*

6f. QUANTITATIVE ANALYSIS. *Laboratory.*

(Sternberg, Howald)

Before beginning actual quantitative analysis, the student is required to make a careful study of the balance and of the method of weighing. The rest of the time is given to exercises in simple gravimetric analysis, with some volumetric analysis, chiefly on analyzed mixtures, closing with a (technical) clay analysis.

Prerequisites: Qualitative analysis.

Required in I., and II.

Sophomore year, first term, six hours per week. Credit three hours.

Text: Moody, *Quaniitative Analysis.*

(Note: Offered after 1919-20 as *Analytical Chemistry.*)

15f. ENGINEERING CHEMISTRY. *Lectures.* (Turner)

There is nothing more essential to the practical engineer of today, no matter in which of the special branches he is working, than an intimate knowledge of the chemistry as well as the mechanics of materials. In this course are taken up in order the chemistry of fuels, industrial waters, lubricants, building materials, lime and cement, paving and wood preservation, paints and varnishes, and explosives.

One hour per week is devoted to reports by the students on topics of interest gleaned from the industrial journals.

Prerequisites: Chemistry 6f, and 6w.

Required in II.

First term, three hours per week. Credit three hours.

Text: Benson, *Industrial Chemistry.*
Manuscript Notes.

17w. INDUSTRIAL CHEMISTRY. *Lectures.* (Turner)

This is essentially an advanced course in Applied Chemistry. As considerable time is spent in the course in General Chemistry in discussing its application in the industries, a certain elementary knowledge of the subject is presupposed.

No attempt is made to burden the student with the usual mass of detail concerning the various standard processes, although a certain amount of textbook work is required. The application of physico-chemical methods to the solution of practical industrial problems is considered of primary importance and receives the maximum amount of attention. The theories underlying the more typical industrial operations are taken up, some time being devoted to discussions on drying, evaporation, crystallization, filtration, heat-transfer, distillation, etc.

The specific industries studied are selected for the typical operations they involve rather than in an attempt to cover the entire field. The selections may be made from the following, and may vary from year to year. The Acid Industrials, Ammonia and Alkali, Fertilizers, Commercial Chemicals, Distillation of Coal and Wood, Soaps, Oil Industries, Sugar and Glucose, Paper, Industrial Alcohol, Laundering, Textiles and Dyeing, Leather, etc.

Required in VII.

Prerequisites: 123f.

This course must be accompanied by Chemistry 18w.

Junior year, second term, three hours per week. Credit three hours.

Text: Rogers, *Industrial Chemistry.*
Kremann-Potts, *Applications of Physico-Chemical Theory.*
Manuscript Notes.
Reference.

17f. INDUSTRIAL CHEMISTRY. *Lectures.* (Turner)

A continuation of 17w, together with a consideration of the design, erection and equipment of chemical plants.

Required in VII.

Prerequisite: Chemistry 17w.

Senior year, first term, two hours per week. Credit two hours, including the Chemical Part of the Senior Trip or its equivalent.

Text and Reference: Dyson and Clarkson, *Chemical Works, Their Design, Erection and Equipment.*
Manuscript Notes and Blue Prints.

18w. INDUSTRIAL CHEMISTRY. *Plant.*

(Turner, Lane, Nichols)

This course is designed to accompany the lectures in Industrial Chemistry and to give the student an opportunity to revise his pre-acquired knowledge to fit large-scale operations. It is purposed that the chemical engineers should at this point in their course be required to demonstrate their ability in putting to practical use in the works those principles of chemistry and mechanical and electrical engineering which they may have learned in the more or less preparatory courses.

A detailed description of the plant with all its machinery and accessories cannot be given as yet, since all of the equipment has not been definitely decided on. It is the intention, however, to equip this laboratory as completely as possible with most of the appliances necessary for medium-scale operations. The plant will be arranged to illustrate the methods used in commercial chemical works, and the actual working of each process will be in charge of a superintendent appointed from among the students. This man is to be solely responsible for the success or failure of the work under his direction, and each man in the course must occupy this position in turn. The other students are to be arranged into a working force suitable to the process in hand.

The actual manufacture of some of the materials studied in Chemistry 17w is to be carried out, special attention being paid to yields and cost of manufacture.

This course must be accompanied by Chemistry 17w.

Required in VII.

Junior year, second term, six hours per week. Credit three hours.

Text: Rogers, *Laboratory Guide of Industrial Chemistry.*
Manuscript Notes and Blue Prints.
Reference Works.

18f. INDUSTRIAL CHEMISTRY. *Plant.*

(Turner, Lane, Nichols)

A continuation of 18w.

Prerequisite: Chemistry 18w.

This course must be accompanied by Chemistry 17f.

Senior year, first term, six hours per week. Credit three hours.

Text and Reference: As above.

21w. ORGANIC CHEMISTRY. *Lectures.* (Dunlap)

The course is an introduction to the simple organic compounds. Special emphasis is placed on the structure and nomenclature of the aliphatic series.

Prerequisites: Chemistry 1w, 2w.

Required in VII.

Sophomore year, first term, two hours per week. Credit two hours.

Text: Cohen, *Theoretical Organic Chemistry.*

Note:—In 1919-20 this course will be three hours per week. Credit three hours.

22w. ORGANIC CHEMISTRY. *Laboratory.* (Dunlap)

Preparation and purification of typical alphatic compounds, illustrating general methods of synthesis and technique of manipulations.

Prerequisites: Must be accompanied by Chemistry 21w.

Required in VII.

Sophomore year, first term, nine hours a week. Credit four and one-half hours.

Text: Cohen, *Practical Organic Chemistry.*

23w. INDUSTRIAL ECONOMICS. *Lectures.* (Turner)

This subject commences with a rather extended reading course in Pure Political Economy, which is to serve as a foundation for subsequent application to industrial problems.

While the student is acquiring this economic perspective, the subjects of Business Administration, which includes Accounting Systems, Purchasing, Selling, etc., Patents, Industrial Organization, Professional Ethics, Factory Hygiene and Scientific Management are discussed. The latter part of the course consists of lectures in and reading assignments on the following topics: Effect of Economic Conditions on Location of Chemical Plants, Price and Value of Products, Markets and Transportation, Labor, Legislation relating to the Use and Manufacture of Chemicals, Industrial Insurance, Competition, Exports and Imports and the Exploitation of Chemical Ideas.

Prerequisites: Chemistry 35f.

Required in VII.

Junior year, second term, three hours per week. Credit three hours.

Text: Ely, *Outlines of Economics.*
Manuscript Notes.

24f. CHEMICAL ENGINEERING DATA. *Laboratory.* (Turner)

To continue and supplement the work described in Chemistry 23w. To consist mainly of individual research in the collection and compilation of data concerning the administrative as well as the scientific side of Chemical Manufacturing. An attempt is made to gain some insight into the manner in which the office collects, files and interprets the facts and figures furnished by the works. Graphical methods of presentation of the information gathered are studied, and cost, efficiency and valuation curves constructed from data furnished by the industries.

Prerequisite: Chemistry 23w.

First term, three hours per week. Credit one and one-half hours.

25w. ELECTRO-CHEMISTRY. *Lectures.* (Sternberg)

A study of the theories of electrolysis, conductance of electrolytes, electromotive force, polarization.

Prerequisites: Chemistry 35f. Physics 4f.

Required in II., and VII.

Junior year, second term, two hours a week. Credit two hours.

Text: LeBlanc, *Electro-chemistry.*

26w. ELECTRO-CHEMISTRY. *Laboratory.* (Sternberg)

Measurements of conductivity, electromotive force, resistance single potentials; electro-deposition of metals, electro-analysis.

Prerequisites: Must be accompanied by Chemistry 25w.

Required in II., and VII.

Junior year, second term, six hours a week. Credit three hours.

Texts: Findlay, *Practical Physical Chemistry.*
Watts, *Laboratory Course in Electro-chemistry.*

31f. ANALYTICAL CHEMISTRY. *Lectures.* (Sternberg)

The first twelve periods will be devoted to a discussion of Qualitative Analytical methods. During the remainder of this course the following subjects will be discussed:—The balance, weights, and the process of weighing; simple gravimetric analysis; volumetric instruments, their calibration and use; volumetric analysis, standard solutions, and indicators.

Problems in the calculations of analytical chemistry are also discussed.

Prerequisites: Chemistry 2f and 2w. To be accompanied by Chemistry 32f.

Required in VII.

Sophomore year, first term, two hours per week. Credit two hours.

Text: Stieglitz, *Qualitative Chemical Analysis.*
Manuscript Notes.

Note:—In 1919-20, the entire time will be devoted to quantitative consideration.

32f. ANALYTICAL CHEMISTRY. *Laboratory.*

(Sternberg, Howald)

The student will devote the first eighteen laboratory periods to the qualitative separation and detection of the metals.

The application of the principles of Quantitative Analysis as illustrated in the simpler Gravimetric and Volumetric determinations will then be taken up.

It is purposed in this course to lay a broad foundation of analytical principles upon which the student may build up by subsequent practice.

Prerequisites: To be accompanied by Chemistry 31f.

Required in VII.

Sophomore year, first term, twelve hours per week. Credit six hours.

Text: Blasdale, *Quantitative Analysis.*
Manuscript Notes.

Note:—In 1919-20 the entire time will be devoted to quantative analysis.

34w. FUEL AND GAS ANALYSIS. *Laboratory.*

(Sternberg)

A more or less practical course in fuel and gas testing especially adapted to the needs of the Mechanical and Electrical Engineer.

Prerequisite: Chemistry 1w and 2w.

Required in V., and VI.

Sophomore year, second term, three hours per week. Credit one and one-half hours.

Text: Gill, *Engine Room Chemistry.*

35f. PHYSICAL CHEMISTRY. *Lectures.* (Sternberg)

While some attention is paid to the application of physical methods to chemistry, and the qualitative and quantitative theories of chemical equilibria as given by the phase rule and the mass law, the special stress in this course is laid on the study of the effects of the equilibrium factors on chemical reactions.

Prerequisites: Chemistry 6w or 32w. Physics 3w and 4w. To be accompanied by Chemistry 36f.

Required in II. and VII.

Junior year, first term, three hours per week. Credit three hours.

Text: Lewis, *A System oj Physical Chemistry.*
Manuscript Notes.

36f. PHYSICAL CHEMISTRY. *Laboratory.*

(Sternberg)

Laboratory to accompany Chemistry 35f.

Prerequisites: Same as 35f.

Required in II. and VII.

Junior year, first term, six hours per week. Credit three hours.

Text: Findlay, *Practical Physical Chemistry.*

38. JUNIOR TRIP. At the end of the school year, the members of the Junior Class take a three weeks' trip to more distant chemical plants. Credit may also be obtained for this trip in the following manner: The student may obtain employment at some chemical plant of his own selection, for a period of not less

than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the chemical industry of the district in which he is employed. Affidavit must be furnished by the student, signed by the proper official of the chemical plant, stating the time of such employment and nature of work.

Required of candidates for the degree of B. S. in Chemical Engineering.

Prerequisites: 17w, 18w.

112w. WATER ANALYSIS. *Laboratory.* (Sternberg)

This course is designed to meet the wants of engineering students. Sanitary water analysis and boiler water analysis are offered, although students interested in geology may substitute mineral water analysis for some of the work.

Prerequisite: Chemistry 6f or 32f.

Elective, second term, six hours per week. Credit three hours.

120f. ORGANIC ANALYSIS. *Laboratory.* (Sternberg)

A laboratory course in the analysis of commercial products.

Prerequisites: Chemistry 21w and 22w.

Elective six hours per week. Credit three hours.

122w. INDUSTRIAL ELECTRO-CHEMISTRY. *Laboratory.* (Sternberg)

A laboratory course in the construction, testing and operation of primary and storage cells; preparation of inorganic and organic compounds by means of electrolysis; electroplating.

Prerequisites: 25w and 26w.

Elective six hours per week. Credit three hours.

123f. ADVANCED ORGANIC CHEMISTRY. *Lectures.* (Dunlap)

A general review of the whole field of the aliphatic and aromatic compounds, followed by an intensive study of some phase of industrial organic manufacture. Lectures, assigned reading, recitations, and reports on the manufacture of special organic products such as dyes, rubber, cellulose, sugars, etc.

Prerequisite: 21w.

Junior year, first term, three hours per week, credit three hours.

124f. ADVANCED ORGANIC CHEMISTRY. *Chemistry.*

(Dunlap)

Advanced preparations followed by intensive study of some problems selected for the special needs and ability of the student.

Prerequisite: To be accompanied by 123f.

Junior year, first term, six hours per week, credit three hours.

125w. GENERAL ORGANIC PROCESSES. *Lectures.*

(Dunlap)

Lectures, assigned readings, and reports on such processes as oxidation, reduction, sulfonation, esterification, etc.

Prerequisite: 123f.

Elective, second term, two hours per week, credit two hours.

126w. SPECIAL ORGANIC LABORATORY. *Laboratory.*

(Dunlap)

Work to accompany 125w. Students are assigned special problems according to their training and fitness.

Prerequisite To be accompanied by 125w.

Elective, second term, six hours per week, credit three hours.

200, 202, 204 f. and w. SENIOR PROBLEMS. *Laboratory.*

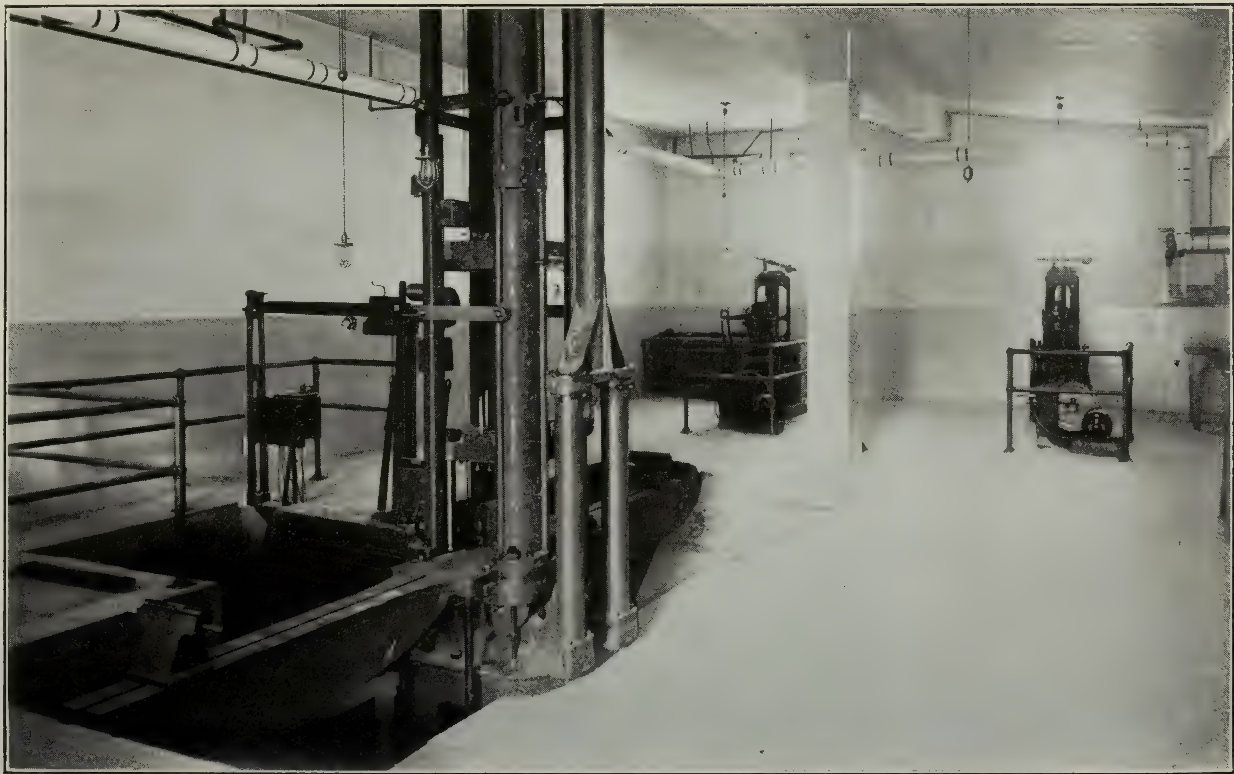
(Turner, Dunlap, Sternberg)

For senior students who show special aptitude, a number of original problems are usually available. These problems require close attention to laboratory work, consistent search in the literature, and much home work in co-ordinating results, and should be elected only by students of a serious turn of mind who intend later to follow research in pure or applied chemistry as a specialty: for such men, this course serves as introductory to independent work.

Prerequisite 125 hours credit in IV. or VII.

Elective, twelve hours per week, credit six hours.

CAMPUS VIEW.



MATERIALS TESTING LABORATORY.

CIVIL ENGINEERING

PROFESSOR HARRIS, ASSISTANT PROFESSORS McCANDLISS,* WALLIS AND ARMSBY, MR. BURKHART, MR. MORRIS, MR. STUBBINS†.

The Department of Civil Engineering has its lecture rooms, drafting rooms, offices and department library in Norwood Hall. The hydraulics laboratory, and the locker rooms for field equipment, are in the Power Plant Building.

The Laboratory for Testing Materials and the Cement Testing Laboratory, together with office, supply and computation rooms, occupy almost the entire ground floor of Parker Hall.

The plan of study is designed to afford such training, that the graduates will be prepared to perform at once the minor duties in the various branches of the profession. Especial stress is laid upon proficiency in field work, drafting and the design of engineering structures.

For field work the department is equipped with twenty transits, five of which are complete mining instruments with side and top telescopes, and fifteen wye and dumpy levels, representing the principal makes and types of construction. Additional equipment includes a solar compass, a surveyor's compass, three geologist's compasses, four Brunten transits, thirteen plane tables, two sextants, and a liberal supply of hand levels, barometers, clinometers, dip-needles, angle prisms, chains, tapes, level rods, stadia rods, range poles, etc.

The field work is so outlined that the student has an opportunity to judge the relative merits of the various types of field instruments.

An important feature of the instrument room is the locker system. Due to the scope of the equipment it has been possible to arrange in separate lockers complete equipment for each surveying squad.

For the hydrographic field work the department is liberally equipped with current meters, gauges, floats, etc.

The hydrographic field is not outlined with the regularly catalogued courses but is given as a special course for Seniors in the School of Civil Engineering. The work is usually conducted on the Gasconade river.

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*On leave First Term.

†First semester.

The department has at its disposal three well equipped drafting rooms.

The laboratory for testing materials is equipped with one 200,000 pound capacity universal testing machine of the Olsen type, which is capable of testing specimens eight feet long in either tension or compression, and specimens in cross bending 16 ft. long between supports. It also contains two machines, each of 50,000 pound capacity, of the Riehle type, which are used for testing small specimens in tension, compression and cross-bending; one 60,000 inch-pound capacity torsion machine of the Olsen type, and one machine used for demonstration of the action of levers, and for testing small specimens in cross bendings. All machines in this laboratory are direct connected motor driven. The necessary small equipment, such as extensometers, compressometers, etc., is ample for the needs of the classes, and comprises only the most modern types of instruments.

This laboratory affords facilities for: Research in the design and the methods of failure of structures, the study of the physical characteristics and composition of materials, and the determination of the laws controlling the behavior of stressed and unstressed members.

The cement testing laboratory is equipped for making complete physical tests of cement, concrete and concrete aggregates, and for investigations of the proper proportioning of concrete. The equipment consists of two standard tension testing machines; two Vicat apparatus; several specific gravity apparatus; one electric drying oven; one standard steamer; an autoclave; a moist closet; apparatus for determination of specific gravity of, and voids in, concrete aggregate; several sets of standard sieves; standard cylindrical molds for concrete; and an ample supply of standard tension briquette molds, graduates, trowels, spatulas and other small apparatus.

Courses.

1f. PLANE SURVEYING. *Lectures.* (Armsby, Burkhart)

The theory of Plane Surveying, including the adjustments and uses of transits, levels, and the minor instruments; land surveying; traverses; levelling; determination of meridian; topographic surveying and mapping; and the usual computations used in connection with plane surveying.

Prerequisites: Mathematics 1f, 3f. To accompany Civil Engineering 4f.

Required in III.

Sophomore year, first term, two lectures per week. Credit two hours.

2. PLANE SURVEYING. *Lectures and Laboratory.*

(Burkhart)

The theory and practice of Plane Surveying, including the adjustments and uses of transits, levels, and minor instruments; land surveying; traverses; levelling; determination of meridian; mapping; and the usual computations used in connection with Plane Surveying. The notes taken in the field are used for computation and mapping, helping to emphasize the practical nature of the work done, and also affording a check on the field work.

The simpler problems are conducted on and about the campus, the work being referenced to stations of a triangulation system, the bearings and lengths of sides of which have been accurately determined, thus affording checks on the accuracy of the student work.

Prerequisites: To be accompanied or preceded by mathematics 1f and 3f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, one lecture, one recitation, one hour preparation and two afternoons per week.

Credit three units. Offered in 1919-20

4. TOPOGRAPHIC SURVEYING. *Laboratory.* (Armsby)

A continuation of the work given in Civil Engineering 2, with the addition of some of the simpler astronomical observations, base line measurement, triangulation, stadia and plane table work, road traversing, and other problems. A complete topographical map of a small area is made.

Prerequisites: Civil Engineering 2.

Required in III.

Freshman year, second term, two afternoons per week. Credit two units. Offered in 1919-20.

4f. PLANE SURVEYING. *Laboratory.*

(Armsby, Burkhart, Morris)

A laboratory course to accompany Civil Engineering 1f. The problems discussed in the classroom are taken up in the field and drafting room, and the students are given thorough drills in each, to familiarize them with the usual field and office methods. During the winter a complete map of a portion of the town or campus is plotted from the notes taken in the field earlier in the term, thus helping to emphasize the practical nature of the work done, and also affording a check on the field work.

The simpler problems are conducted on and about the campus, the work being referenced to stations of a triangulation system, the bearings and lengths of sides of which have been accurately determined, thus affording a check on the student work.

Prerequisites: Mathematics 1f, 3f. To be accompanied by Civil Engineering 1f.

Required in III.

Sophomore year, first term, three afternoons per week.

Credit four and one-half hours.

2f. PLANE SURVEYING. *Laboratory.*

(Burkhart, Stubbins, Morris)

An abridgement of courses 1f and 4f for students in courses other than Civil Engineering. Very much the same ground is covered, but the work is necessarily abbreviated in scope, and slightly modified to better suit the needs of the student taking the work.

Prerequisites: Mathematics 1f, 3f.

Required in I., V., and VI. This course cannot be substituted for Civil Engineering 1f and 4f.

Sophomore year, first term, two afternoons per week. Credit three hours.

This course will not be given in 1919-20.

4w. ADVANCED SURVEYING. *Laboratory.* (Armsby)

A continuation of the work given in Civil Engineering 4f, with the addition of some of the simpler astronomical observations, base line measurement, triangulation, stadia and plane table work, road traversing, and other problems. A complete topographical map of a small area is made.

Prerequisites: Civil Engineering 1f and 4f.

Required in III.

Sophomore year, second term, two afternoons per week. Credit three hours.

6w. CIVIL ENGINEERING DRAWING. *Laboratory.*

(Armsby)

This course is designed to represent the conditions of office and drafting room. Especial stress is laid on neatness, accuracy, and dispatch. The course covers practice in freehand lettering for titles, maps, etc., topographical signs, drafting conventions, and the drawing of simple engineering structures.

Prerequisites: Civil Engineering 1f and 4f, Mechanical Engineering 2w.

Required in III.
Sophomore year, second term, one afternoon per week.
Credit one and one-half hours.

7f. RAILROAD SURVEYING. *Lectures and Laboratory.*
(Armsby)

This course treats of the theory and practice of surveying pertaining to the location, construction and maintenance of railroads.

The course is designed to acquaint the student with the theory of simple, compound, and reversed curves; frogs; switches; turnouts; crossovers; and earthwork computations. The afternoon period is devoted to field and office problems.

Prerequisites: Civil Engineering 1f and 4f or 2f.

Required in I. and III.

Junior year, first term, one lecture and one afternoon per week.

Credit two and one-half hours.

8f. RAILROAD SURVEYING. *Laboratory.* (Armsby)

Field and office practice. A short line of railroad is projected and located in the field, the object of the work being to acquaint the student with the details and sequence of each engineering operation included in the general problem of railroad location.

Prerequisite: Must be accompanied by Civil Engineering 7f.

Required in III.

Junior year, first term, one afternoon per week. Credit one and one-half hours.

7w. RAILROAD SURVEYING. *Lectures and Laboratory.*
(Armsby)

This course is intended to extend the scope of Civil Engineering 7f, and treats of the theory of spirals, earthwork, haul, overhaul, and estimates.

Prerequisite: Civil Engineering 7f.

Required in III.

Junior year, second term, one lecture and one afternoon per week. Credit two and one-half hours.

9f. HYDRAULICS. *Lectures and Laboratory.* (Harris)

The theory of hydrostatics and of hydraulics, and its application to the dependent problems in engineering practice; determination of empirical coefficients and their application in deter-

mining the flow of water through orifices, weirs, pipes, canals, and rivers.

Prerequisites: Mathematics 15f.

Required in I., II., and III.

Junior year, first term, three lectures and one afternoon per week. Credit four and one-half hours.

11f. MASONRY CONSTRUCTION. *Lectures.*

(Harris, Armsby)

The object of this course is to study the fundamental principles underlying the selection, testing, preparation, and use of the various building materials in masonry structures. The treatment of ordinary and pile foundations, foundations under water, dams, retaining walls, piers, abutments, and culverts are successively taken up and studied.

Prerequisites: Mathematics 15f. To be accompanied by Mathematics 19f.

Required in III.

Junior year, first term, three lectures per week. Credit three hours.

11w. REINFORCED CONCRETE. *Lectures and Laboratory.*

(Harris)

This course covers the theory and design of concrete-steel beams, slabs, tanks, dams, culverts, conduits, retaining walls, and columns.

Prerequisites: Mathematics 19f and Civil Engineering 11f.

Required in III.

Junior year, second term, two lectures and one afternoon per week. Credit three and one-half hours.

13w. ROADS AND PAVEMENTS. *Lectures.* (Wallis)

This course treats of the economic properties of road materials; the location, construction and maintenance of roads and streets; types of improvements, their designs and estimates of cost.

A special feature of this course is the seminar work, which is conducted one hour each week. Throughout the year each member of the class is required to prepare and present to the class papers on some assigned subject relative to roads and pavements.

Prerequisites: Civil Engineering 1f, 4f, and 11f.

Required in III.

Junior year, second term, three lectures per week. Credit three hours.

15w. STRESSES. *Lectures and Laboratory.* (Harris)

This course covers the graphic and analytic determination of stresses in the simpler engineering structures under their various loads, including derricks, roof trusses, and single span bridges.

Prerequisites: Mathematics 17w, 19f.

Required in III.

Junior year, second term, two lectures and two afternoons per week. Credit five hours.

15f. FRAMED STRUCTURES. *Lectures and Laboratory.* (Harris)

This course is a continuation of Civil Engineering 15w and covers the complete design, with estimates and bills of materials of plate girders, bridges, roofs, towers, steel building frames, and the like.

Prerequisites: Civil Engineering 15w.

Required in III.

Senior year, first term, three lectures and two afternoons per week. Credit six hours.

17w. CONTRACTS. *Lectures.* (Harris)

A lecture course in the law of contracts, and the preparation of specifications.

Prerequisites: Completion of the Junior course.

Required in III.

Senior year, second term, two lectures per week. Credit two hours.

19f. WATER SUPPLY. *Lectures.* (Wallis)

This course covers the selection, storing, transporting, purification, and delivering of water to cities and towns.

Prerequisites: Civil Engineering 9f, and 11w.

Required in III.

Senior year, first term, three lectures per week. Credit three hours.

20f. MATERIALS TESTING LABORATORIES. *Laboratory.* (Armsby, Burkhart)

In this course the student's time is divided between the cement testing laboratory and the laboratory for testing materials. Early in the semester the work consists of making complete physical tests of standard brands of natural and Portland cements, and the

effects of such adulterants as free lime, sulphur acids and alkalies upon the strength and durability of the same. The laws governing the proportionment of concretes, and mortars, are verified experimentally.

Tests are conducted to show the relationship of strength to density in mortars and concrete; the effect of fineness of grinding of a cement on its setting properties; the effect of clay upon the strength and density of concrete; the effect of commercial waterproofing ingredients upon the porosity of concrete, and such other determinations as are appropriate to a laboratory of this character. The entire course is designed to impress the student with economic truths, the adaptability and the limitations of the use of mortars and concretes for materials of engineering construction.

The latter part of the semester is devoted to the physical tests in tension, compression, flexure and torsion of such materials as iron, steel, timber, stone, brick and other clay products; the study of the behavior of these materials under stress and the interpretation of the results of the investigations.

Prerequisite: Mathematics 15f.

Required in III.

Junior year, first term, two afternoons per week. Credit three hours.

20w. MATERIALS TESTING LABORATORIES. *Laboratory.*

(Armsby)

The character of the work done in this course is essentially the same as that of Engineering Laboratories 20f, except that only one-half as much time is devoted to the work, necessitating fewer experiments and a more limited scope.

The major portion of the time is taken up with the physical tests of iron, steel, and timber, in tension, compression, cross-bending, and torsion; the study of the behavior of these materials when subjected to stress; the interpretation of the results of the tests, and the reports upon the same.

The work in the cement testing laboratory consists of a few exercises in the physical testing of natural and portland cements. (This course is not to be substituted for Engineering Laboratory 20f.)

Prerequisite: Mathematics 15f.

Required in I., V., and VI.

Junior year, second term, one afternoon per week. Credit one and one-half hours.

21f. IRRIGATION AND DRAINAGE ENGINEERING.

Lectures. (Harris)

The time here allotted is given to the study of special problems arising in the design of irrigation projects, such as location of the main canal and its head works, mapping the lands, locating the secondary canals, special methods of measuring and delivering the water, necessary water consumption, etc., and to the study of the cause and control of foods, protection of river banks, improvements of navigation, and protection and improvement of harbors.

Prerequisites: Civil Engineering 9f and 11w.

Elective.

Senior year, first term, three lectures per week. Credit three hours.

23f. RAILROAD ECONOMICS. *Lectures.* (Armsby)

This course treats of the economic principles of the locations, revision, operation, and financing of railroads. The scope of the work covers train resistances under varying conditions of traffic, grade and curvature; locomotive performance; valuation of railroad properties; grade separation, etc.

Prerequisites: Civil Engineering 7f and 8f. To accompany Civil Engineering 7w.

Required in III.

Junior year, second term, two lectures per week. Credit two hours.

29w. SANITARY ENGINEERING. *Lectures.* (Wallis)

Treats of the precautions necessary to protect water supplies from pollution and the methods available for the purification of sewage; also the construction of sewer systems for the collection and transportation of sewage and storm water.

Prerequisites: Civil Engineering 19f.

Required in III.

Senior year, second term, three lectures per week. Credit three hours.

31f. MASONRY DESIGN. *Lectures and Laboratory.*

(Harris)

This course is a logical continuation of Civil Engineering 11w. It includes the analysis and design of high masonry dams, reinforced concrete dams, long span arches, stacks, and the like. A portion of the time is given to tunneling and difficult foundations.

Prerequisites: Civil Engineering 11w.

Required in III.

Senior year, first term, three lectures and two afternoons per week. Credit six hours.

32w. DESIGNING. *Laboratory.* (Harris)

The work in this course is selected to accord with the line of work in which the student expects or desires to specialize. He is required to find his material in the library, and to inform himself as to the best current practice relative to the problem assigned. Throughout this semester the student is required to keep informed as to the current Civil Engineering literature.

Prerequisites: Civil Engineering 15f and 31f.

Required in III.

Senior year, second term, three afternoons per week. Credit four and one-half hours.

33w. MUNICIPAL ECONOMICS. *Lectures.* (Wallis)

This course covers in a broad way the principles of municipal economics and management.

Prerequisites: Civil Engineering 7w, 19f, 31f.

Required in III.

Senior year, second term, three lectures per week. Credit three hours.

35f. CITY PLANNING. *Lectures.* (Wallis)

In this course the various phases of city planning are considered in a broad way and from a distinctly engineering standpoint.

Following a brief review of the history of city planning, the following topics are treated as fully as the time permits: the city planning movement; the street system, including the arrangement and width of traffic and of residential or minor streets; street traffic problems and regulation; street details; urban transportation systems; railroads in relation to the street system; housing in relation to city planning; public regulation of private property, including regulation of outdoor advertising, districting for uses and heights of buildings, and methods of taking land for public purposes; industrial districts; residential and industrial decentralization; industrial and satellite cities; land subdivision; municipal land policies; public buildings and civic centers; park systems and recreational facilities; city planning legislation, etc.

Prerequisites:

Elective.

Senior year, first term, two lectures per week. Credit two hours.

37w. LANDSCAPE ENGINEERING. *Lectures and Laboratory.* (Wallis)

The lectures of this course treat briefly the principles of landscape design from the standpoint of the civil or the landscape engineer.

The application of these principles is brought out by designing problems which are worked out in the drafting room.

Prerequisites: Civil Engineering 6w and 13w and Mechanical Engineering 2w.

Elective.

Senior year, second term, one lecture and one afternoon per week. Credit two and one-half hours.

38. TOPOGRAPHIC RECONNAISSANCE. *Laboratory.* (Armsby)

This course, given in 1918-19 under the title of "Military Mapping," takes up the approximate methods of topographical reconnaissance and mapping in use in the United States Army. Its aim is to train the student to make, with extremely simple apparatus, topographic maps of sufficient accuracy for many engineering purposes.

Sketching contours, use of board for determining differences in elevation, and rapid mapping work are the essential features of the work.

Elective.

First or second term, one afternoon per week. Credit one and one-half hour.

ENGLISH AND MODERN FOREIGN LANGUAGES

PROFESSOR BARLEY, ASSISTANT PROFESSORS DANIELS AND JOHNSON, MR. STUBBS.

ENGLISH.

1f. RHETORIC AND COMPOSITION. *Lectures.* (Johnson)

A study of the theory of exposition, with especial attention to the paragraph and to the correct and the effective sentence. A reasonable amount of written work is required of the student in order that he may gain facility in the use of clear, idiomatic English. In many instances this written work is drawn from other courses pursued by the student, thereby correlating his practice in composition with his immediate interests and activities. There is also given weekly practice in oral composition.

Prerequisites: College entrance requirements in English.

Required in all courses.

Freshman year, first term, three hours a week. Credit three hours.

1w. RHETORIC AND COMPOSITION. *Lectures.* (Johnson)

This course is a continuation of 1f. Attention is given to the theory of punctuation and to the writing of long themes. Some outside reading is required.

Prerequisite: 1f.

Required in all courses.

Freshman year, second term, three hours a week. Credit three hours.

3f. THE SHORT STORY. *Lectures.* (Barley)

An extended reading course in selected short stories, together with a critical study of representative specimens of this literary type.

Prerequisites: English 1f and 1w.

Sophomore year, first term, three hours a week. Credit three hours.

3w. THE NOVEL. *Lectures.* (Barley)

A reading course in representative English and American novels of the nineteenth century and of the present day.

Prerequisites: English 1f and 1w.

Sophomore year, second term, two hours a week. Credit two hours.

23f. MASTERPIECES. *Lectures.* (Barley)

Critical study of selected literary masterpieces.

Prerequisites: English 1f and 1w.

Sophomore year, first term, three hours a week. Credit three hours.

23w. AMERICAN LITERATURE. *Lectures.* (Barley)

An advanced course in the history and development of literature in this country, with particular reference to the period following the Civil War.

Prerequisites: English 1f and 1w.

Sophomore year, second term, two hours a week. Credit two hours.

Either 3f or 23f and either 3w or 23w are required of Sophomores in all courses.

5f. SHAKESPEARE. *Lectures.* (Barley)

Five or six of Shakespeare's plays are carefully studied in class and several more are required as collateral reading.

Prerequisites: Sophomore requirements in English.

Required in Curriculum IV.

Junior year, first term, three hours a week. Credit three hours.

5w. CONTEMPORARY DRAMA. *Lectures.* (Barley)

A reading course in the drama of the present day, supplemented by lectures.

Prerequisites: As in 5f.

Required in Curriculum IV.

Junior year, second term, three hours a week. Credit three hours.

19f. ENGINEERING WRITING. *Lectures.* (Barley)

An advanced course in oral and written technical reports and in the details and problems of engineering writing.

Senior year, first term, two hours a week. Elective. Credit two hours.

MODERN FOREIGN LANGUAGES.

Students in Curriculum I are required to complete one year's work in German, or French, or Spanish, and those having completed Elementary Spanish may elect a second year's work in this language; those in Curricula II, V, VI and VII must complete one year's work in German, or French, or Spanish, and may elect an additional year's work in the language already pursued; those in Curricula III must complete two years' work in German, or French, or Spanish; those in Curricula IV must complete two years' work in German or French.

No advanced standing will be given for high school credits in language except by examination.

At present the United States Geological Survey requires French or German in its civil service examinations. Students who expect to qualify for this work are advised to elect one or both of these languages.

Students who expect to engage in work in Central America or South America are advised to elect Spanish.

Beginning with 1919-1920, Modern Foreign Languages will not be given in the Freshman curriculum, but will be offered in the other curricula according to announcements to be made later.

7f. ELEMENTARY GERMAN. *Lectures.*

Open to all Freshmen.

Freshman year, first term, three hours a week. Credit three hours.

7w. ELEMENTARY GERMAN. *Lectures.*

Prerequisites: German 7f.

Freshman year, second term, three hours a week. Credit three hours.

9f. SCIENTIFIC GERMAN. *Lectures.* (Daniels)

Prerequisites: German 7f and 7w.

Sophomore year, first term, three hours a week. Credit three hours.

Text: Kip, *Scientific German Reader.*

9w. RESEARCH GERMAN. *Lectures.* (Daniels)

Prerequisites: German 9f.

Sophomore year, second term, two hours a week. Credit two hours.

11f. ELEMENTARY FRENCH. *Lectures.* (Daniels)

Open to all Freshmen.

Freshman year, first term, three hours a week. Credit three hours.

11w. ELEMENTARY FRENCH. *Lectures.* (Daniels)

Prerequisite: French 11f.

Freshman year, second term, three hours a week. Credit three hours.

13f. SCIENTIFIC FRENCH. *Lectures.* (Daniels)

Prerequisites: French 11f and 11w.

Sophomore year, first term, three hours a week. Credit three hours.

13w. RESEARCH FRENCH. *Lectures.* (Daniels)

Prerequisites: French 13f.

Sophomore year, second term, two hours a week. Credit two hours.

15f. ELEMENTARY SPANISH. *Lectures.* (Daniels)

Open to all Freshmen except those in Curricula IV.

Freshman year, first term, three hours a week. Credit three hours.

15w. ELEMENTARY SPANISH. *Lectures.* (Daniels)

Prerequisites: Spanish 15f.

Freshman year, second term, three hours a week. Credit three hours.

17f. COMMERCIAL SPANISH. *Lectures.* (Daniels)

Prerequisites: Spanish 15f and 15w.

Sophomore year, first term, three hours a week. Credit three hours.

17w. CONVERSATIONAL SPANISH. *Lectures.* (Daniels)

Prerequisites: Spanish 17f.

Sophomore year, second term, two hours a week. Credit two hours.

GEOLOGY AND MINERALOGY

PROFESSOR COX, ASSOCIATE PROFESSOR DAKE, ASSISTANT PROFESSOR MUILENBURG, MR. RACKETT, MR. MORRIS.

Equipment.

The geological and mineralogical laboratories are on the second floor of Norwood Hall. They are supplied with suitable tables for the examination of rocks and minerals. The equipment of the department includes reference, working, and cabinet collections of minerals, ores, rocks, and fossils and many specimens illustrating metallurgical processes; a working collection of wooden and glass crystal models and natural crystals; full sets of maps and reports and a set of geological relief models.

There is also a collection of thirty-five hundred specimens representing the mineral wealth of Missouri, consisting of coal clays of many sorts, building stones, and ores of lead, zinc, iron, and copper. The minerals occurring as gangue with the metalliferous deposits of the state are also well represented. There is also a complete collection of the economic minerals of Missouri and a good economic geological collection representing the world at large. This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago and was presented to the School of Mines and Metallurgy by the General Assembly in 1895.

In addition to the above-mentioned collection the State Board of Equalization assigned to the school the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the school a large amount of valuable equipment.

The museums contain crystals and minerals from various parts of the world, the important mining districts of the State of Missouri being especially well represented by the economic collection from Southwestern Missouri, the great geological relief map, polished stone tables and ornamental stones, and other complete collections of the Missouri Building of the St. Louis Exposition.

Rock-breaking and section machines, instruments for geological surveys, petrographic microscopes, thin mineral and rock sections, and lantern slides are included in the equipment of this department.

1f. CRYSTALLOGRAPHY. *Lectures and Laboratory.*

(Muilenburg, Rackett)

Elementary crystallography, including the study of models and natural crystals, with oral and written recitations. The chief object of the course is to give the student an understanding of the general principles of crystallography and the ability to recognize crystal forms, especially the systems, by the use of few, if any, instruments. The necessary lectures are given during the regular laboratory time.

Required in I. and IV. with geology major and in VII.

Junior year, first term, three hours laboratory work per week. Credit one and one-half hours.

Text: Butler, *Geometrical Crystallography.*

1w. MINERALOGY. *Lectures and Laboratory.*

(Muilenburg, Morris)

A study of the fundamental principles of classification and the distinctive characteristics of minerals, with a thorough drill in the recognition of about one hundred and seventy-five species. This includes the determination of unknowns by means of the blowpipe and only those principles of crystallography which are essential in the study of minerals.

Prerequisites: Chemistry 1w, 3w and 4w.

Required in I. and in IV. with geology major.

Sophomore year, second term, nine hours laboratory work per week. Credit four and one-half hours.

Texts: Dana, *Textbook of Mineralogy.*
Butler, *Handbook of Mineralogy.*

2f. GENERAL ENGINEERING MINERALOGY.

Lectures and Laboratory. (Muilenburg)

A study of the common ore and rock-forming minerals and types of rocks. The necessary lectures are given during the regular laboratory periods. This course is intended for the Civil, Mechanical, Electrical, and Chemical Engineering students, the same ground being covered more thoroughly by Course 1f, 1b and 5w, so that full credit may not be given for it and one or more of these courses, and it may not be substituted for any part of them.

Prerequisite: Chemistry 1w.

Required in III. and VII.

Junior year, first term, three hours per week. Credit one and one-half hours.

11f. OPTICAL MINERALOGY. (See Geology 11f.)

GEOLOGY.

Courses.

3f. GENERAL GEOLOGY. *Lectures.* (Dake)

Dynamic geology. A somewhat detailed account of geologic processes. The larger topics are treated more exhaustively than in the required text. Local field trips.

Prerequisites: Either 2f or 1w.

Required in I., and in IV. with geology major.

Junior year, first term, three hours per week. Credit three hours.

Text: Cleland, *Geology, Physical and Historical.*

3w. GENERAL GEOLOGY. *Lectures.* (Dake)

Introductory structural and historical geology. Typical geologic structures and their effects upon the physiographic development of the earth's surface are considered for the first eight weeks. Geologic history is then traced from the beginning of the record to the present, as much attention as possible being paid to the rock systems and their contained fossils, with some reference to geographic changes and organic evolution.

Prerequisites: Geology 3f. To be accompanied by Geology 4w.

Required in I., and in IV. with geology major.

Junior year, second term, three hours per week. Credit three hours.

Text: Cleland, *Geology, Physical and Historical.*

4w. GENERAL GEOLOGY. *Laboratory.* (Dake)

Laboratory exercises in reading topographic and geologic maps; in the construction of profile and geologic sections and simple geologic maps. These exercises are designed to illustrate the subject-matter of the earlier lectures of Course 3w, and occupy nine weeks; excursions and field practice in elementary geologic mapping the remainder of the semester.

Prerequisite: Geology 3f. To accompany Geology 3w.

Required in I., and in IV. with geology major.

Junior year, second term, six hours per week. Credit three hours.

References: Hayes, *Handbook for Field Geologists.*
Geikie, *Structural and Field Geology.*
Prof. Paper, *U. S. Geol. Survey No. 60.*

5w. LITHOLOGY. *Lectures and Laboratory.* (Muilenburg)

A study of the structure, texture, mineral and chemical composition, and the manner of formation and occurrences of igneous, sedimentary, and metamorphic rocks. This course is adequate for all general field determinations.

Prerequisites: Mineralogy 1w; to be accompanied by Geology 3w.

Required in I., and in IV. with geology major.

Junior year, second term, one hour lecture and three hours of laboratory work per week. Credit two and one-half hours.

Text: Kemp, *Handbook of Rocks.*

7f. GEOLOGY OF THE UNITED STATES. *Lectures.* (Dake)

The physiography, stratigraphy, economic products, and geologic structure and history of the chief geologic divisions of the United States are summarized in the lectures.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in IV. with geology major.

Senior year, first term, three hours per week. Credit three hours.

Texts: Blackwelder, *Handbook of Regional Geology: the United States.*

9f. ECONOMIC GEOLOGY. *Lectures.* (Cox)

A study of the origin, occurrence, and distribution of the metallic ores. Various type deposits of the world are considered, special attention being given to those of the United States. Written reports are required for each district studied; reference always being made to the original reports, thus familiarizing the student with the various technical publications and their usage. The ores of the following metals are considered: zinc, lead, copper, gold, silver, nickel, cobalt, iron, manganese, tin, mercury, tungsten, platinum, and aluminum. Trips to local points of interest.

Candidates for the degree of Bachelor of Science in Mine Engineering or Metallurgy taking this course must also take the geology part of Course 12, Senior Trip.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with general mining or geology options, and in IV. with geology major.

Senior year, first term, four hours per week. Credit four hours.

Text: No text required. Reference largely to reports by the United States and state geological surveys.

9w. ECONOMIC GEOLOGY. *Lectures.* (Cox)

A study of the origin, occurrence, and distribution of the economic deposits of the non-metals. Reference is made to those technical reports which describe the most important deposits, and a written summary is required for each district studied. The subjects covered are as follows: coal, oil and gas, clays, cements, gypsum, salt, sulphur, sulphides, building stone, abrasives, gems, soils, and fertilizers. Trips to local points of interest.

Students taking this course who do not take Course 12 will be given special work while the remainder of the class is taking the Senior Trip.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with geology option, and in IV. with geology major.

Senior year, second term, three hours per week. Credit three hours.

Text: No text required. Reference largely to reports of the United States and state geological surveys.

11f. PETROGRAPHY. *Lectures and Laboratory.* (Cox)

The semester is devoted to the study of optics as applied to the determination of minerals by the polarizing microscope, the identification of minerals in thin sections, and the grinding of rock and mineral thin sections.

Prerequisites: Geology 3w, 4w, and 5w, and Physics 3w and 4w; to be accompanied by Mineralogy 1f.

Senior year, first term, three lectures and nine hours of laboratory work per week. Credit seven and one-half hours.

Text: Luquer, *Minerals in Rock Sections.*

11w. PETROGRAPHY. *Lectures and Laboratory.* (Cox)

A study of nomenclature, relations and alterations of rocks together with the petrographic analysis and the recalculation of the chemical analysis of rocks.

Prerequisite: Geology 11f.

Senior year, second term, three lectures and six hours of laboratory work per week. Credit six hours.

Texts: Kemp, *Handbook of Rocks*, with one of the following:
Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannson, *Determination of Rock-Forming Minerals.*

12. SENIOR TRIP. (Cox)

During the second semester of the Senior year a three weeks' trip is taken to Joplin, St. Louis, Flat River, and other points in

the Southeastern Missouri Lead District, for the purpose of studying mining, ore dressing, smelting, geology, and power plants of these districts. The geology portion of these trips is required of all candidates for the degrees in Mining Engineering and Metallurgy who have taken Course 9f.

Prerequisite: Geology 9f.

Senior year, second term.

13w. STRUCTURAL GEOLOGY. *Lectures.* (Cox)

An advanced course in the study of rock deformation, including a review of the theories of the origin of the earth; a discussion of the zones of rock fracture and rock flowage; a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates, and pseudo-conglomerates; and a consideration of mountain-building forces, together with the horizontal and vertical depth affected, with application to special districts.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with geology option and in IV. with geology major.

Senior year, second term, three hours per week. Credit three hours.

14f. FIELD GEOLOGY. *Field Work.* (Cox)

The course consists of both field and laboratory work, the two being varied to suit the weather. The field work consists of the making of topographic and geologic maps, with suitable sections and reports, of assigned areas. The laboratory work includes the making of sections and maps and the final drafting of the field work.

The instruments used include the plane table, hand level, aneroid barometer and telescopic alidade.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with geology option and in IV. with geology major.

Senior year, first term, six hours per week. Credit three hours.

15w. GEOLOGY CONFERENCE. (Cox)

The conference consists of a discussion by the students and instructors of geologic problems and literature, each student being assigned certain work upon which he must report to the class.

Prerequisite: Geology 9f.

Senior year, second term, one hour per week. Credit one hour.

16w. ADVANCED GEOLOGY. *Laboratory.* (Dake)

An advanced course in the study and interpretation of topographic and geologic maps.

Prerequisites: Geology 3w and 4w.

Required in IV. with geology major.

Senior year, second term, nine lectures and ninety hours laboratory work for the semester. Credit three hours.

17f. OIL AND GAS. *Lectures.* (Cox)

A detailed study of the origin and occurrence of the various oil and gas deposits.

Prerequisites: Mineralogy 1w or 2f and Geology 3w.

Senior year, first term, one hour a week. Credit one hour.

17w. OIL AND GAS. *Lectures.* (Cox)

Field methods in petroleum geology.

Prerequisite: Geology 17f.

Senior year, second term, one hour a week. Credit one hour.

18w. OIL AND GAS. *Laboratory.* (Cox)

Laboratory work in connection with course 17w, and in the interpretation and preparation of maps.

Prerequisites: Must be accompanied by Geology 17w and 4w.

Senior year, second term, three hours a week. Credit 1.5 hours.

19f. GENERAL ENGINEERING GEOLOGY. *Lectures.* (Dake)

An introductory course in general geology adapted to the general needs of students in Civil, Mechanical, Electrical and Chemical Engineering. The work covers dynamical geology with such details as is possible in the time allowed.

Prerequisites: To be accompanied by Mineralogy 2f or preceded by Mineralogy 1w.

Required in III. and VII.

Junior year, first term, one hour per week. Credit one hour.

Text: Ries and Watson, *Engineering Geology.*

21w. GENERAL ENGINEERING GEOLOGY. *Lectures.* (Dake)

An introductory course in structural and historical geology and in non-metallic economic geology adapted to the needs of

students in Civil, Mechanical, Electrical, and Chemical Engineering.

Prerequisites: Either Geology 19f or 3f.

Required in III.

Junior year, second term, two hours per week. Credit two hours.

Text: Ries and Watson, *Engineering Geology.*

22w. GENERAL ENGINEERING GEOLOGY. *Laboratory.*

(Dake)

A review of the minerals and rocks studied in Mineralogy 2f, together with laboratory studies in topographic and geologic maps and profiles. Adapted to the needs of students in Civil, Mechanical, Electrical and Chemical Engineering.

Prerequisites: To be accompanied by Geology 21w.

Required in III.

Junior year, second term, two afternoons per week. Credit three hours.

24f. STRATIGRAPHIC AND METAMORPHIC GEOLOGY.

Lectures. (Muilenburg)

An advanced course in stratigraphic and metamorphic geology, special emphasis being given to sedimentation.

Prerequisites: Geology 3w, 4w and 5w.

Senior year, first term, three hours per week. Credit three hours.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior class make a three weeks' trip to Colorado and Utah, or other mining districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students to be signed by the mine or mill officials, by whom he was employed, stating the time of such employment and nature of the work.

Required of candidates for degrees of B. S. in Mining and Metallurgy.

Prerequisites: Mining 5w, Geology 3w and 4w, and Metallurgy 39w.

40. SPECIAL GEOLOGY.

Special studies in geology, hours and subjects to be arranged with each student.

MATHEMATICS

Professor Dean, Mr. Hinsch.

While the utility of mathematical study as a mental discipline is duly recognized, the ultimate intention of the student is kept in mind, and the matter and methods of the courses are adjusted, as nearly as possible, to meet the demands of subsequent studies and professional practice.

COURSES.

1f. COLLEGE ALGEBRA. *Lectures.* (Hinsch)

Theory of limits, logarithms, progressions, binomial theorem, undetermined coefficients, series and solution of higher equations. Special attention is paid to graphical solutions and practical applications.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, three hours per week, first term. Credit three hours.

Text: Hall and Knight, *College Algebra.*

3f. PLANE TRIGONOMETRY. *Lectures.* (Hinsch)

Solution of plane triangles, reduction and transformation of trigonometric expressions, solution of trigonometric equations.

Prerequisite: Mathematics 1a.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first term, two hours per week. Credit two hours.

Text: Taylor and Puryear, *Trigonometry.*

5w. SPHERICAL TRIGONOMETRY. *Lectures.* (Hinsch)

Continuation of Mathematics 3f, taking up more difficult parts of analytical trigonometry, solution of spherical triangles, and simpler problems of spherical astronomy.

Prerequisite: Mathematics 3f.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second term, two hours per week. Credit two hours.

Text: Taylor and Puryear, *Trigonometry.*

7w. ANALYTICAL GEOMETRY. *Lectures.* (Hinsch)

The object of this course is to familiarize the student with methods rather than with any particular set of curves. Special attention, however, is given to those forms of the equations of the conic sections which occur in technical literature.

Prerequisite: Mathematics 5w.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second term, three hours per week. Credit three hours.

Text: Smith and Granville, *Elementary Analysis.*

9f. DIFFERENTIAL CALCULUS. *Lectures.* (Dean)

The student is thoroughly drilled in the derivation of formulae and the application of derivatives in the solution of problems in maxima and minima, in curve tracing, velocity, and acceleration, expansion of functions.

Prerequisite: Mathematics 7w.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first twelve weeks of first term, four hours per week. Credit three hours.

Text: Phillips, *Calculus.*
Notes by Professor.

11f, 11w. INTEGRAL CALCULUS. *Lectures.* (Dean)

The student is drilled in the integration of forms occurring in mechanics and physics, in evaluating areas, moments, moments of inertia, in finding centers of gravity, center of stress, and in the derivation and application of fundamental formulae of hydrostatics and hydraulics.

Prerequisite: Mathematics 9f.

Required in I., II., III., V., VI. and VII.

Sophomore year, four hours per week, after 9f, and first twelve weeks of second term. Credit one hour on each semester.

Text: Phillips, *Calculus.*
Notes by Professor.

13w. DIFFERENTIAL EQUATIONS. (Dean)

Integrable forms of the differential equations of mechanics and physics, applications of partial differentiation and partial integration, theory of attraction, dynamics of a particle, and thermodynamics of perfect gases.

Prerequisites: Mathematics 11a and 11b.

Required in I., II., III., V., VI and VII.

Sophomore year, second term, four hours per week after 11w. Credit three hours.

Text: Phillips, *Calculus.*
Notes by Professor.

31f. THE THEORY OF STRUCTURES. *Lectures.* (Dean)

The purpose of this course is to present in a thorough and logical manner the fundamental theories upon which the design of all structures is based and to illustrate their application by numerous examples. No attempt is made to treat of the design of complete structures, but the design of the more important elements of which all structures are composed is fully considered. Senior elective, three lecture hours per week. Credit three hours.

Prerequisites: Mathematics 1f to 13w, and Mechanics 17w to 19f.

Text: Spofford, *The Theory of Structures*, Chapters I., II., III., IV., V., VI. and VII., supplemented by lectures and notes.

31w. THE THEORY OF STRUCTURES. *Lectures.* (Dean)

Continuation of 31f. Credit three hours.

Text: Spofford, *The Theory of Structures*, Chapters VIII.-XX., inclusive, supplemented by lectures and notes.

33f. APPLIED MECHANICS. *Lectures.* (Dean)

This course is intended to give that general knowledge of the mechanics of structures and machines which should accompany the detailed study of any special branch of engineering. It will include the following subjects:

Statics of Structures, Kinematics of Machines, Dynamics of Machines, Stiffness and Strength of Materials, Transmission and Conversion of Energy by Fluids.

Senior elective, three hours per week. Credit three hours.

Text: Cotterill, *Applied Mechanics*, supplemented by lectures and notes.

33w. APPLIED MECHANICS. *Lectures.* (Dean)

Continuation of 33f. Credit three hours.

35f. MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. *Lectures.* (Dean)

This course is intended only for students with special mathematical aptitude. Credit three hours.

Texts: Pidduck, *A Treatise on Electricity.*
Berg, *Electrical Engineering.*
Lyons, *Problems in Electrical Engineering.*
Pender, *Principles of Electrical Engineering.*

35w. MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. (Dean)

Continuation of 35f.

Whether the subject is treated from the standpoint of pure physics or that of electrical engineering depends on the choice of the students electing the course.

MECHANICS

ASSOCIATE PROFESSOR GARRETT*, ASSISTANT PROFESSOR McCANDLISS.

17w. MECHANICS. *Lectures.* (Garrett)

The first half of the semester is devoted to statics. It is the aim of the course to train the student in the application of fundamental principles to practical problems. The second half of the semester is given to kinematics and kinetics with technical applications.

Prerequisites: Mathematics 11f.

Required in I., II., III., V., VI. and VII.

Sophomore year, second term, four hours per week. Credit four hours.

Text: Maurer, *Technical Mechanics.*

19f. MECHANICS OF MATERIALS. *Lectures.* (Garrett)

A general course in the mechanics of materials. As the subject is developed the student is given a thorough drill in the application of principles to simple problems of design and in the use of standard handbooks.

Prerequisite: Mechanics 17w.

Required in I., II., III., V., VI. and VII.

Junior year, first term, four hours per week. Credit four hours.

Text: Houghton, *Mechanics of Materials.*
Notes by instructor.

21w. ADVANCED MECHANICS OF MATERIALS. *Lectures.* (Garrett)

This course begins with a more advanced study of certain parts of the work covered in Mechanics 19f and includes further a discussion of such subjects as combined stresses, inertia circle and ellipse, kern, beams of unsymmetrical section, curved beams, flat plates and thick cylinders.

Prerequisite: Mechanics 19f.

Elective, second term, three hours per week. Credit three hours.

Offered in 1918-19.

*On leave after March 1.

23f. ADVANCED MECHANICS. *Lectures.* (Garrett)

This course is designed primarily as a senior elective in curriculum V. or VI. While the subject-matter of the course is selected with reference to the needs of the class and may vary somewhat from year to year, it is for the most part along lines suggested by the following topics: Periodic Motion, Whirling Shafts and Rotating Discs, Vibration, Balancing.

Prerequisite: Mechanics 19f.

Elective, first term, three hours per week. Credit three hours.

Not offered in 1918-19.

GAS ENGINE SQUAD.

MECHANICAL HALL.

MECHANICAL ENGINEERING

PROFESSOR DICKERSON, ASSISTANT PROFESSORS BOWEN AND WALLIS, MR. COLE*, MR. BARNARD, MR. LOTTMAN.

The course for Juniors and Seniors in Mechanical Engineering are conducted in the lecture and drafting rooms in Norwood Hall, the experimental laboratories are located in the Power Plant Building and the drawing and shop practice are given in Mechanical Hall.

Equipment.

The power plant is used for experimental purposes, and comprises a modern equipped laboratory. The machinery available for testing purposes includes four 130-h. p. Heine safety boilers, especially equipped with openings in the setting for temperature and draft measurements in furnace, combustion chamber and flues; a 13 by 14 Erie Ball engine direct connected to a 75 kw. 220 volt D. C. Westinghouse generator; a 10 by 12 Ideal engine direct connected to a 50 kw. 220 volt D. C. Westinghouse generator; a 12 by 11 General Electric marine type engine direct connected to a 50 k. v. a. 220 volts, 60 cycle, three-phase generator with direct connected exciter; a 10 kw. 220 volt Curtis steam turbo generator; a six stage 36-h. p. Kerr steam turbine complete with prony brake on the same bed plate; a 9 by 14 Brownell engine equipped with a rope friction brake; a 5 by 7 Davis and Rankin vertical engine equipped with a Prony brake; a 21-h. p. Otto four strokes per cycle gas engine belted to a two-stage Worthington centrifugal pump; a 3-h. p. Ferro two strokes per cycle portable gas engine; a 8-h. p. K.-E. Bessemer gas engine equipped to run on either gasoline or crude oil; a 6H Continental automobile motor arranged for testing; a D. C. switchboard with a panel for each generator and two for distribution switches, equipped with a Tirrill voltage regulator, a Thompson recording watt-hour meter, circuit breakers for each generator, and the usual ammeters and voltmeter; an A. C. switchboard with voltmeter, ammeters, wattmeter, and watt-hour meter. The pneumatic equipment includes a Laidlow-Dunn-Gordon air compressor, a Rand Imperial air compressor, a Sullivan straight-line two-stage air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, a 60-inch Buffalo forge blower, an experimental fan capable of delivering 250 cu. ft. of air per second at

*On leave of absence, 1918-1919.

six inches of water pressure, two cylindrical steel tanks 6 ft. by 15 ft. for measuring air by water displacement.

The Ball and Ideal engines; also the air compressors and steam turbines are connected to a 20-in. shell Griscom-Russell surface condenser with a Blake vacuum pump.

The laboratory also contains a complete Wickes vertical boiler and engine ten horsepower plant fitted for testing purposes.

There is a complete steam and pumping plant at the experimental mine, where laboratory practice is also obtained.

The instrument room of the Mechanical Laboratory contains a good line of instruments used for testing purposes, some of which are listed below.

Parr and Roland-Wild coal calorimeters; Ellison throttling and evaporating moisture calorimeters; Peabody, and Schaeffer and Budenberg moisture calorimeters; General Electric Co., and Gebhart portable steam flow meters; Hays, and Orsat flue gas apparatus; Crosby, Thompson, Robertson, Schaeffer and Budenberg, and American steam and gas engine indicators; Schaeffer and Budenberg continuous drum indicator; Amsler, Crosby, Willis, and Keuffel and Esser planimeters; various indicating and recording steam gages; Crosby steam gage testers; Tycos portable pyrometer; cold and hot water meters; thermometers, manometers, tachometers and speed counters; and Prony friction brakes.

The shops are thoroughly equipped with machinery and benches adapted to instruction. The wood bench-work room contains twenty double benches with separate sets of hand tools. The lathe room is equipped with twenty Fay & Egan 12-in. swing college wood lathes and iron shears. The other machines in the lathe room include a Fay & Egan 27-in. planer, a Fay & Egan band saw with 30-in. wheels, Fay & Egan joiner, an Oliver universal saw-table, two Oliver wood trimmers, a mortise machine, jig saw, grindstones, and other necessary tools.

For instruction in forge work there are twenty-four Buffalo Forge Company down-draft forges, power hammer, drill press, power shears, and grinder.

The metal-working room contains:

- One 20-in. by 8-ft. Reed Lathe.
- One 12-in. by 6-ft. Reed Lathe.
- One 14-in. by 6-ft. Hendey Lathe.
- One 14-in. by 6-ft. American Lathe.
- Four 13-in. by 5-ft. South Bend Lathes.
- One No. 2A Brown & Sharpe Universal Milling Machine.
- One No. 2 Universal Norton Grinder.
- One Hendey 15-in. Pillar Shaper.
- One Dwight Sensitive Drill.
- One Barnes 22-in. Swing Upright Drill Press.
- One 24-in. Morse Double Emery Grinder.

One 24-in. by 24-in, by 6-ft. Chandler Planer.
Two Greenard Arbor Presses, No. 3½ and No. 1.
One No. 1 Burr Cold Saw.
One 3-fire Chicago Flexible Shaft Gas Furnace.
One portable Buffalo forge.

All of the above-mentioned iron-working machinery is of latest design and driven by individual motors. The benches in the lathe room have hardwood tops mounted on standard Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work. Also a standard portable oxy-acetylene welding and cutting outfit of the latest type is included in the shop equipment.

The drawing rooms are equipped with individual drawing tables and will accommodate two hundred and forty students working in two sections.

The blue print room contains a 42-in. x 60-in. Pease-Vertical electric blue printing machine and a sheet washer.

Courses.

1w. DESCRIPTIVE GEOMETRY. *Lectures and Laboratory.*

A (Wallis, Barnard)

This course covers the fundamental principles of projective drawing with special reference to their application to engineering drawing.

Prerequisites: Mechanical Engineering 2f.

Required in I., II., III., IV., V., VI., VI. and VII.

Freshman year, second term, one lecture and one laboratory per week. Credit two and one-half hours.

2f. BEGINNING DRAWING. *Laboratory.*

(Wallis, Barnard)

By means of a carefully graded series of exercises the student is drilled in the correct use of drafting instruments, especial emphasis being placed on the production of work of quality rather than of quantity. The student is required to master the standard style of single stroke lettering used on engineering drawings.

Perequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first term, two (one 2 hr. and one 3 hr. period) laboratories per week. Credit two and one-half hours.

2w. ADVANCED DRAWING. *Laboratory.*

(Wallis, Barnard)

This course is a continuation of Mechanical Engineering 2f and includes work in isometric, obligue and perspective projection as well as a careful drill in freehand sketching of machine parts in orthographic and perspective projection.

Perequisites: Mechanical Engineering 2f.

Required in 1., II., III., IV., V., VI. and VII.

Freshman year, second term, one laboratory per week. Credit one and one-half hours.

3f. MECHANISM. *Lectures.* (Dickerson)

In this course are studied the principles which underly the action of the elementary combinations of which all machines are composed, also the motions and velocities of linkages, cams, and gears.

Perequisistes: Mechanical Engineering 4f and 18w.

Required in V. and VI.

Junior year, first term, three hours per week. Credit three hours.

Text: Keown, *Mechanism.*

4f. MACHINE DRAWING. *Laboratory.* (Wallis)

The work of this course familiarizes the student with drafting room conventions as applied to machine drawing and is intended to prepare him as to drafting technique for the advanced work machine design.

Perequistes: Mechanical Engineering 1w, 2f and 2w.

Required in V. and VI.

Sophomore year, first term, one laboratory, per week. Credit one and one-half hours.

5f and 5w. BOILERS AND ENGINES. *Lectures.*

(Dickerson)

This course takes up the consideration of the construction and operation of the various well known types of boilers and engines and their accessories. Under the boiler part is included chimneys and boiler settings; under the engine part is included the simple and multi-expansion Corliss engines, uniflow engines, steam turbines, and gas engines.

Perequisites: Physics 1f, 2f, 3w and 4w.

Required in I., III., VI. and VII.

Junior year, first term, three hours per week. Credit three hours.

Text: Spanker, Green and Marshall, *Elements of Steam Engineering.*

6w. STEAM LABORATORY. *Laboratory.* (Dickerson)

A laboratory course given to familiarize the student with the instruments used in engineering investigations, also to give training in securing data, reporting, and analysing results obtained from experiments conducted on boilers and steam and gas engines.

Prerequisites: To accompany or to be preceded by Mechanical Engineering 5f and 5w.

Required in III., VI. and VII.

Junior year, second term, three hours per week. Credit one and one-half hours.

7w. VALVE GEARS. *Lectures and Problems.* (Dickerson)

The study of Valve Gears is essentially a study of the relative motions and simultaneous positions of the piston, crank and value of an engine. This course deals principally with the valve and valve diagrams, shaft governor, Corliss and poppet valve gears and the reversing gears as applied to steam engines.

Prerequisites: Mechanical Engineering 3f and 5f or 5w.

Required in V.

Junior year, second term, two hours per week. Credit two hours.

Text: Fessenden, *Valve Gears.*

8w. MECHANICAL LABORATORY. *Laboratory.*

(Dickerson, Lottman)

A course similar to Mechanical Engineering 6w. This course also includes experiments on air compressors.

Prerequisite: To accompany or to be preceded by Mechanical Engineering 5f or 5w.

Required I. and VI.

Junior year, second term, six hours per week. Credit three hours.

9f. POWER PLANTS. *Lectures and Laboratory.*

(Dickerson)

This course attempts to cover the broad scope of classifying the various types of machines used in power plants according to their adaptability to service, space, economy, and cost; also to give the student some idea of the commercial side of engineering.

A laboratory period gives opportunity for studying the general lay-outs and operation of power plants and also experimental data which is obtained from complete plant tests.

Prerequisites: Mechanical Engineering 5f or 5w and 6w or 8w.

Required in V. and VI.

Senior year, first term, six hours per week. Credit four and one-half hours.

Text: Fernald & Orrok, *Engineering of Power Plants.*

9w. THERMODYNAMICS. *Lectures.* (Dickerson)

A course in theoretical thermodynamics, covering the laws and fundamental equations of gases and their application to the steam engine. Also a discussion of the principles governing the action of air compressors, gas engines, refrigerating machines and steam turbines.

Prerequisites: Mechanical Engineering 5f or 5w and 6w or 8w.

Required in V. and VI.

Junior year, second term, three hours per week. Credit three hours.

Text: Moyer and Calderwood, *Engineering Thermodynamics.*

11f. COMPRESSED AIR. *Lectures.* (Harris)

This course covers the theory of air compression, both in reciprocating machines and in centrifugal machines; also the measurement and transmission of air, and its application to the industries.

The problems include laboratory work in testing compressors and fans, determination of friction in pipes, flow through orifices, and the solution of problems, such as come up in practice.

Prerequisites: Mathematics 19f, Mechanical Engineering 5f or 5w and 6w or 8w.

Elective.

Senior year, first term, three hours per week. Credit three hours.

Text: Harris, *Compressed Air.*

12f or w. WOOD WORK. *Laboratory.* (Bowen)

The work in the wood shop aims to train the student in the use of wood-working tools and machinery and to familiarize him with the properties of the common woods. All work is done from drawings. One hour of period is spent in explanations and demonstrations of both wood and metal working shop methods.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first term, four hours per week. Credit two hours.

FORGE SHOP.

MACHINE SHOP.

14f or w. FORGE WORK. *Laboratory.* (Bowen)

This course begins with simple exercises in drawing, upsetting, bending, twisting, punching, and welding. The work gradually becomes more difficult, such as making eye-bolts, chains, and tongs. Tool-making is then begun by making screwdrivers, hammers, chisels, and a complete set of lathe tools to be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. The student is made familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting iron, steel, brass and stone. The final part of this work is the testing of rock-drills on different grades of steel used.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second term, three hours per week. Credit one and one-half hours.

15w. INTERNAL COMBUSTION ENGINES. *Lectures.*

(Dickerson)

This course includes the theory of Internal Combustion Engines as well as the construction and operating features of the various types of automobile, stationery oil engines of small sizes, Diesel and other engines of large types. The gas producer is also studied.

Prerequisites: Mathematics 19f, Mechanical Engineering 5f or 5w and 6w or 8w.

Elective.

Senior year, second term, three hours per week. Credit three hours.

Text: Sterling, *Internal Combustion Engines.*

16w. FOUNDRY. *Laboratory.* (Bowen)

This course comprises instruction and practice in the use of foundry tools and equipment and in tempering of sand, preparation of sands for core binding and core making. It also includes bench, floor, pit, sweep, and machine molding; charging of cupola and pouring of metals.

Prerequisites: Mechanical Engineering 12f and 14w.

Required in V. and VI.

Sophomore year, first term, three hours per week. Credit one and one-half hours.

17w. HEATING AND VENTILATING. *Lectures and Problems.* (Dickerson)

A study of the principles of design for heating and ventilating private and public buildings. An example is used for illustrating the various systems of furnace heating, hot water and steam and comparisons made. The central heating system is also studied.

Prerequisites: Mechanical Engineering 9w.

Elective.

Senior year, second term, three hours per week. Credit three hours.

Text: Hoffman, *Handbook for Heating and Ventilating Engineers.*

18w. MACHINE SHOP. *Laboratory.* (Bowen)

This course begins with chipping to a line, filing to a dimension, and scraping to a surface plate. Machine operation is then begun; the principles and uses of the drill-press, lathe, planer, shaper, and milling machines are taught by lectures followed by practical work at each machine. After a reasonable time, skill is attained in operating the various machines through a course of graded exercises. In this work use is made of the vernier, micrometer, thread-micrometer, and gear-tooth caliper. Entire machines are also built, such as lathes, gasoline engines, wood trimmers. The degree of accuracy thus acquired enables the student to use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

Prerequisites: Mechanical Engineering 14f or 14w.

First or second term, six hours per week. Credit three hours.

19w. INDUSTRIAL ENGINEERING: *Lectures.* (Dickerson)

This course comprises lectures on the construction and the arrangement of buildings for manufacturing plants; the heating and lighting of such buildings; the installation and arrangement of machinery in them and also the maintenance of plants is considered. Shop management is especially studied during the course.

Prerequisite: Mechanical Engineering 9f.

Required in V.

Senior year, second term, three hours per week. Credit three hours.

20f. MACHINE DESIGN. *Laboratory.* (Dickerson)

The individual shapes and strength of the working parts of machines are studied, keeping in mind the frame upon which

these parts are to be assembled. Such problems as the design of bearings, clutches, hooks, pulleys and also machine tools as found in machine shops.

Prerequisites: Mechanical Engineering 3f, 4f, and 18w.

Required in V.

Junior year, first term, three hours per week. Credit one and one-half hours.

Text: Halsey, *Handbook for Machine Designers.*

20w. ENGINE DESIGN. *Laboratory.* (Dickerson)

In this course the student completely designs a steam or gas engine, making comparisons with "Manufacturers' Averages." The report includes the calculation and detailed drawings.

Prerequisite: Mechanical Engineering 20f.

Required in V.

Senior year, second term, six hours per week. Credit three hours.

Text: Halsey, *Handbook for Machine Designers.*

22f. MACHINE DESIGN. *Laboratory.* (Dickerson)

This course takes up the design of the shapes and strength of the working parts of machines similar to that in 20f.

Prerequisites: Mechanical Engineering 3f, 4f, and 18w.

Required in VI.

Junior year, first term, three hours per week. Credit one and one-half hours.

24f. POWER PLANT DESIGN. *Laboratory.*

(Dickerson)

The student makes preliminary surveys, and from this, with what further data needed, designs a complete power plant. The generation and sale of the power as well as the by-products, such as steam for heating, are taken into account. Drawings for pro-plants are made and plans for reconstruction are worked up. Maintenance, stand by losses, insurance and depreciation are considered in the selection of the machinery.

Prerequisite: Mechanical Engineering 9f.

Required in V.

Senior year, first term, six hours per week. Credit three hours.

METALLURGY AND ORE DRESSING

Associate Professor Mann, Assistant Professor Clayton, Mr. Gill, Mr. Scott.

Equipment.

The assay laboratory has a floor space of forty-eight hundred square feet. In the main room are twenty coal-fired, double-muffle assay furnaces, twelve gasoline-fired muffle furnaces, and ten coke-fired furnaces. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces.

A room 16 by 16 feet, separated from the furnace laboratory by glass partitions, is used for parting. There are in this room the necessary hot plates, acid jars, and annealing muffles. The desks in this laboratory are topped with white tiling.

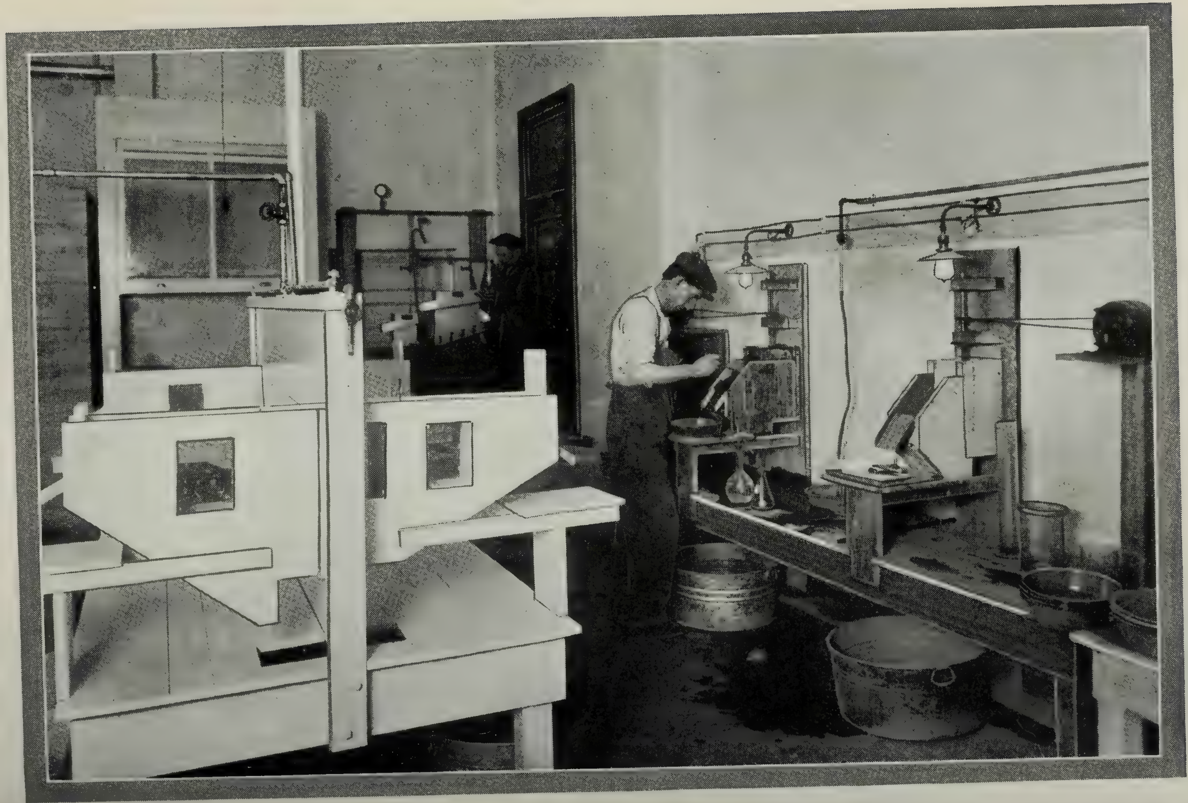
The balance room is 20 by 20 feet and is lighted only from the north. It is easily kept at constant temperature. There are twenty-four balances suitable for weighing gold. A number of these balances have the multiple-rider attachment.

For chemical work in connection with metallurgy there is a well-lighted room having fifty-six lockers, and fifty-six desks. Each desk is provided with gas, compressed air, and water. There is in the room ample hood space; in fact, the laboratory has everything necessary for general chemical work.

There is, in main furnace room, a circular water-jacket blast furnace 20 inches in diameter at the tuyeres and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster, an experimental zinc distilling furnace, direct reading and recording La Chatlier thermo-elctric pyrometers, and a Wanner optical pyrometer.

A stock room, containing chemicals, clay goods, glassware, and other supplies, serves all the laboratories. The ore-sample room is especially well equipped. It contains more than 1,000 samples of ore of varied classes. Each sample is stored away in paper sacks, all ready for issuing to the students. Each sample has been prepared and carefully assayed. Enough of each lot of ore has been prepared to give 200 to 300 samples of the same lot. The sample room, therefore, contains more than 1,000 different samples

ASSAY LABORATORY.



FLOTATION LABORATORY.

of ore, each sample being divided into 200 or more smaller samples, each of the smaller samples being ready for immediate issue.

Throughout the metallurgical and ore-dressing laboratories care has been taken that each furnace, each piece of apparatus, should be so arranged as to be fitted best for that testing work which must be so great a part of the student's work. In all the laboratory work, in addition to demonstrating the theories and principles explained in the classroom, the attempt is made to give the man ability to do a day's work and to teach him to use both his head and his hands.

The main floor of the ore-dressing laboratory occupies a space of forty-eight hundred square feet and a mezzanine floor provides an additional space of thirteen hundred square feet. The equipment of the laboratory is as follows: The crushing and sampling department contains a gyratory breaker, a Dodge breaker, a pair of 9-inch by 12-in. rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests are provided a three-stamp mill, with amalgamated plates and a 3½ foot Huntington mill.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a duplex Callow traveling belt screen, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, one Deister Overstrom table, and a laboratory James table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected, motor-driven centrifugal sand pumps are used for elevating finely crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a small gyratory breaker, a disc grinder, a coffee mill, a pair of rolls, a number of bucking boards and mullers, a laboratory tube mill, a Ro Tap testing Sieve shaker and an electric sample dryer.

The cyanide unit contains a laboratory leaching plant with all necessary tanks, a 16-in. Hendryx clay agitator, a 14-in. Hendryx combination agitator and filter, and a six-leaf 12-in. by 12-in. filter press.

Ores suited to a magnetic concentration are treated on a Knowles magnetic separator, and for the preparation of such ores a cylindrical dryer and roaster, together with a plane impact screen for dry sizing, is provided.

For testing ores by flotation, the laboratory is equipped with machines that represent the latest thing in the way of oil flotation. There are eight machines of the mineral separation type, four of which are of the modified air lift type, one Janney machine (the gift of D. C. Jackling), and one Callow machine. Each machine is arranged so that it can be run independent of all others or in combination.

The laboratory, which is lighted by two "daylight" nitrogen lamps, is well equipped with hot plates, drying areas, water and air pipes, and other equipment that goes toward facilitating work.

We have on hand about one hundred and fifty oils, most of which have been carefully classified acording to their merits as flotation oils. Besides the oils, we have a large number of reagents that are used as addition agents in the flotation process.

Throughout the mill, wherever possible, the practice of driving each machine with an individual motor has been followed.

It is recognized that the school cannot give students, in the brief time at its disposal, that skill which comes from long practice but it is the aim to give such training in the fundamental principles and their application that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

1f. FIRE ASSAYING. *Lectures.* (Gill)

This course deals with the theory of fire assaying as practiced in the laboratory. The points discussed are outlined under Metallurgy 2w.

Prerequisites: Chemistry 1f and 2f.

Required in I.

Junior year, first term, two hours per week. Credit two hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

1w. FIRE ASSAYING. *Lectures.* (Gill)

This course deals with the theory of Fire Assaying as practiced in the laboratory. The points discussed are outlined under metallurgy 2w.

Prerequisites: Chemistry 1f and 2f.

Required in II and VII.

Junior year, second term, two hours per week. Credit two hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

2w. FIRE ASSAYING. *Laboratory.* (Mann, Clayton, Gill, Scott)

This work includes the assay, by scorification and crucible methods of ores from the various districts of the United States. Copper ores, copper mattes, and copper bullions are assayed by fire and by the combination method. Lead ores and furnace products are assayed for lead and for gold and silver. Assays of cyanide solutions, of zinc-box residues, of silver bullion, of gold bullion, of lead bullion and of silver-mill precipitate, are included in this course. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying the student studies the losses occurring. He learns the effects of different schemes of firing the furnaces by making analysis of the flue gases and by pyrometric measurements. The laboratory is so arranged that even with large classes a student is not hampered by other students and he learns to handle a large amount of work with the best utilization of his time.

Prerequisites: Chemistry 1f and 2f. To be preceded by Geology and Mineralogy 1f.

Required in II.

Junior year, second term, nine hours per week. Credit four and one-half hours.

Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

2f. FIRE ASSAYING. *Laboratory.*

This course covers the work outlined in Metallurgy 2w briefly.

Prerequisites: Chemistry 1f and 2f. To be preceded or accompanied by Geology and Mineralogy 1f.

Required in I.

Junior year, first term, six hours per week. Credit three hours.

4w. FIRE ASSAYING. *Laboratory.*

This course attempts to briefly cover some of the more important operations as outlined in Metallurgy 2w.

Prerequisites: Chemistry 1a and 2f.

Required in VII.

Junior year, second term, three hours per week. Credit one and one-half hours.

5f. METALLURGY OF THE NON-FERROUS METALS.

Lectures. (Mann)

This course includes a study of the metallurgy of lead, copper, zinc, gold, silver, tin, antimony, and aluminum. The greater part of the time is spent on the metallurgy of lead, copper, zinc, gold, and silver.

Metallurgy of Lead. The course in the metallurgy of lead includes work along the following general lines: The properties and uses of lead, its alloys, and compounds. The ores of lead and methods and principles of their sale. Principles and practice of sampling ores and products. The general principles made use of in the winning of lead from its ores. The treatment of lead ores in the reverberatory smelting furnace. The winning of lead from its ores by smelting in the ore hearth or Scotch hearth, considerable attention being paid to this method on account of its importance with the ores of the Mississippi Valley. The roasting of lead ores and the strides that have recently been made in this important preliminary to the lead blast-furnace. The winning of ores in the lead blast-furnace. This heading is, of course, an important one in the subject, and under it are taken up the blast-furnace plant, the chemistry of the blast-furnace, the calculation of furnace charges, the calculation of costs of smelting, the handling of products, particularly the smoke or fume. The desilveration of base bullion by means of the Parkes, Pattison, and cupellation processes, as well as by the Betts process. Throughout this course, as well as the other courses in this department, the work is accompanied by problems which bring out the ideas that the classroom work considers.

Texts: Hofman, *Metallurgy of Lead.*
Collins, *Metallurgy of Lead.*
The Articles Appearing in the Technical Journals.

Metallurgy of Copper. The metallurgy of copper is considered along the following general lines: The properties and uses of copper, its compounds, and its alloys. The markets for copper and its ores and principles underlying their sale and price. The ores of copper. The smelting of roasted and oxidized ores of copper to black copper is touched only briefly. The roasting of copper ores as a preliminary to blast-furnace and reverberatory smelting The handling of the smoke from copper furnaces to save the values contained therein and to remove from these gases their injurious constituents. The smelting of roasted ores to matte in the reverberatory furnace. The smelting of roasted ore to matte in the blast-furnace either with or without the attempt to volatilize a considerable portion of the sulphur. The smelting of raw massive

sulphides to matte in the blast-furnace, or pyrite smelting. The converting of copper matte to blister copper in the basic and in the acid converter. The furnace refining of copper. The production of copper from matte by the various roast-reaction of roast smelting methods. The electrolytic of copper.

Texts: Peters, *Practice of Copper Smelting.*
Peters, *Principles of Copper Smelting.*
Hofman, *Metallurgy of Copper.*
References in the Technical Journals.

Metallurgy of Zinc. The metallurgy of zinc is considered under the following headings: The properties and uses of zinc, its alloys, and its compounds. The ores of zinc and the methods and principles underlying their sale. The roasting of zinc ores, with a brief study of the use of zinc ores as a source of sulphuric acid. The distillation of zinc ores and the furnaces suited for this purpose. The factors on which the success of the distillation depends. The manufacture of retors and condensers. The laws of condensation of vapor to liquid and their application to the condensation of zincs vapors. The products of zinc smelting, and the methods of handling and treating these products. The cost of smelting zinc ores figured on the basis of a number of typical ores. The refining of spelter. The markets for spelter and the various brands of spelter. Special schemes other than the ordinary methods that have been used or proposed for use in the winning of zinc from its ores. The manufacture of zinc oxide pigment. Throughout the course problems are given to illustrate the ideas set forth in the class.

Text: Ingalls, *Zinc.*

Metallurgy of Gold and Silver. The metallurgy of gold. The work of this course includes lectures and recitations along the following general lines: The properties of gold, gold alloys, and the compounds of golds. The winning of gold from placer ground by dredging and hydraulicking, including methods of investigating the value of placers. The chlorination and bromination of gold ores are considered more in the light of the historic value of these processes than for their present importance as schemes of gold extraction. The amalgamation methods for silver and gold ores are taken up in detail in the course on ore dressing.

The metallurgy of silver is considered as suggested by the following headings: The properties of silver, of its alloys, and of the compounds of silver. The winning of silver from its ores by the various leaching schemes that were formerly of greater importance than at present. These schemes include the Augustin process, the Ziervogel or Argo process, the various methods of hyposulphite leaching; they are considered only briefly. The greater part of the time of the course in gold and silver is devoted to the study of the

cyanide process, which is considered in considerable detail. The parting of gold and silver by the various acid and electrolytic schemes. The winning of gold and silver from their ores by the various smelting schemes is considered under the head of the metallurgy of lead and copper.

Texts: Rose, *Metallurgy of Gold.*
Collins, *Metallurgy of Silver.*
Julian and Smart, *Cyaniding.*
Clennell, *Cyaniding.*
The Technical Journals.

Prerequisites: Metallurgy 39b and Chemistry 6b.
Senior year, first term, four hours per week. Credit four hours.
Required in II.

5w. METALLURGY OF THE NON-FERROUS METALS

Lectures. (Mann)

This is a continuation of Metallurgy 5f.

Prerequisites: Metallurgy 39w and Chemistry 6b.

Senior year, second term, three hours per week. Credit three hours.

Students working for a degree in either mining or metallurgy who take this course are required to take the metallurgy portion of the Senior Trip. All other students taking this course must either take the metallurgy portion of the Senior Trip or do equivalent work in metallurgy at Rolla.

6f. METALLURGY. *Laboratory.* (Mann, Clayton, Scott)

This course covers the testing of ores for process treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixivation, concentration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods worked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect that freight rates and such other factors have on the treatment which an ore should receive. Experiments are made in the reverberatory and the "pot" roasting of ores, and on blast-furnace smelting of ores. Furnace heat equations are made by each student from data collected by himself.

Prerequisites: Metallurgy 1w, 2w and 3w.
Senior year, first term, four hours per week. Credit 2.5 hours.
Text: Howe, *Metallurgy Laboratory Experiments.*

8f. METALLURGY. *Laboratory.* (Mann)

A more extended course than 6f. Planned for students specializing in metallurgy.

Prerequisites: As in 6f.

Senior year, first term, seven hours per week. Credit four hours.

Recommended for II.

Text: As in 6f.

9w. ELECTRO-METALLURGY. *Lectures.* (Clayton)

Lectures are given covering the electro-metallurgical processes that are in use. Efficiency and engineering calculations based on these processes are given.

Prerequisites: Metallurgy 3w, Physics 1w and 3f, Chemistry 9f, 10f and 7f.

Senior year, second term, four hours per week. Credit four hours.

10w. ELECTRO-METALLURGY. *Laboratory.* (Clayton)

This course gives a study of the principles of electro-metallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed and calculations as to efficiency are made on electric smelting.

Prerequsites: Physics 1w and 3f, Chemistry 9f, 10f and 7f, accompanied by Metallurgy 9f.

Senior year, second term, six hours per week. Credit three hours.

10w. ADVANCED ELECTRO-METALLURGY. *Laboratory.* (Clayton)

This course is a continuation of Metallurgy 10f.

Prerequisites: Physics 1w and 3f, Chemistry 9f, 10f and 7f, Metallurgy 10f.

Senior year, second term, three hours per week. Credit one and one-half hours.

12. SENIOR TRIP.

During the second semester of the Senior year a three weeks' trip is taken to Joplin, St. Louis, Flat River, and other points in the Southeast Missouri Lead District, for the purpose of studying the Mining, Ore Dressing, Smelting, Geology, and Power Plants of

these districts. The metallurgy and ore dressing parts of this trip are required of all candidates for degrees in Mining Engineering and Metallurgy who take Courses 5w Metallurgy and 33w Metallurgy.

Prerequisites: Metallurgy 5b, 33b.

Senior year, second term.

13f. METALLURGY PROBLEMS. (Clayton)

These problems aim to cover the common ones that the metallurgist meets in practice.

Prerequisite: Metallurgy 3w. To accompany Metallurgy 5f.

Senior year, first term, three hours per week. Credit three hours.

Text: Richards, *Metallurgical Calculations.*

15w. METALLURGICAL MEMOIRS. *Lectures.* (Mann)

The student in the Metallurgy Curriculum's required to do considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by each student.

Prerequisite: Metallurgy 5f.

Senior year, second term, one hour per week. Credit, one hour.

19f. METALLURGY PLANT. *Lectures.* (Mann)

The arrangement of various metallurgical works are studied. The advantages and disadvantages of different equipments are given.

Prerequisites: Metallurgy 3w, 5f, and 5w.

Graduate course, first term, two hours per week. Credit two hours.

20f. METALLURGY PLANT DESIGN. *Laboratory.*

(Mann)

This is a drafting-room course and the student is given problems to solve in detail, covering a part of the class room discussions. Each student is required to submit complete drawings, specifications and estimates of cost.

Prerequisites: Shop Practice and Drawing 2w, Metallurgy 3w, 5f, and 5w.

Graduate course, first term, six hours per week. Credit three hours.

21w. CYANIDING. *Lectures.* (Mann)

This course teaches the principle and practice of cyaniding. The student keeps up with the progress in the art. Attention is given in all the work to the cost of operation and to the schemes used and proposed for lessening the cost. A detailed study is made of the types of filter presses, crushing machinery and other devices used in cyanide mills. Cyaniding is compared with other possible methods of treatment.

Prerequisites: Metallurgy 1w, 2w, and 3w.

Graduate course, second term, three hours per week. Credit three hours.

22w. CYANIDING. *Laboratory.* (Mann)

The student in this course has an opportunity to test in the Laboratory the methods discussed in the classroom. The work is not routine, but the experiments are arranged to bring out a point under discussion, or to solve, if possible, the problems occurring at the time in the classroom.

Prerequisites: Metallurgy 1w, 2w, and 3w. To accompany Metallurgy 21f.

Graduate course, second term, six hours per week. Credit three hours.

23w. ORE SUPPLY. *Lectures.* (Mann)

This course is intended to bring out the important subject of ore, flux, and fuel supplies. The subject is studied from a combined commercial and technical standpoint. The problems of valuing fluxes and fuels, of mixing ore so that the mixture shall command the lowest treatment rate, and of preparing, from the reduction works' standpoint, treatment charges for different classes of ores, are studied.

Prerequisites: Metallurgy 5f and 5w.

Graduate course, second term, two hours per week. Credit two hours.

25f. METALLURGICAL RESEARCH: *Laboratory, Reading and Conferences.* (Mann)

Each graduate student elects a subject for special study. It is recommended that the work be along a different line from the subject chosen for thesis. The course consists principally of assigned reading, together with conferences with the professor on matter read. The laboratories are always open for the solving of any problem that may arise.

Prerequisites: Metallurgy 5f and 5w.

Graduate course, first term, three hours per week. Credit three hours.

25w. METALLURGICAL RESEARCH. *Laboratory, Reading and Conferences.* (Mann)

This course is a continuation of Metallurgy 25f.

Prerequisite: Metallurgy 25f.

Graduate course, second term, five hours per week. Credit five hours.

27w. ADVANCED METALLURGICAL PROBLEMS. *Lectures.* (Clayton)

This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions.

Prerequisite: 13f.

Second term, one hour per week, credit one hour.

29f. ALLOYS AND METALLOGRAPHY. *Lectures.* (Clayton)

These lectures deal with the theoretical and practical consideration that influence the structure and properties of alloys of different types.

Prerequisites: Chemistry 7f, Metallurgy 3w.

Senior year, first term, three hours per week. Credit three hours.

30f. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This laboratory course is given in connection with the lectures, and deals chiefly with the micro-structure of iron and steel.

Prerequisites: Chemistry 7f, Metallurgy 39w.

Senior year, first term, three hours per week. Credit 1.5 hours.

32w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This course is intended for those who wish to devote more time to the study of the structure of alloys than is possible with 30w.

Prerequisites: Chemistry 7f, Metallurgy 39w and 41w.

Senior year, second term, six hours per week. Credit three hours.

33f. ORE DRESSING. *Lectures.* (Mann)

In this course the principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are

presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances. The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

Senior year, first term, three hours per week. Credit three hours.

Text: Richards, *Textbook of Ore Dressing.*

33w. ORE DRESSING. *Lectures.* (Mann)

This course is a continuation of Metallurgy 33f.

Prerequisite: Metallurgy 33f.

Senior year, second term, four hours per week. Credit four hours.

Text: Richards, *Textbook of Ore Dressing.*

Students in mining or metallurgy taking this course are required to take the ore dressing of the Senior trip. All other students are required to take the trip or do equivalent work in ore dressing at Rolla.

34f. ORE DRESSING PROBLEMS. *Laboratory.* (Mann)

In this course advanced work is given in connection with the design of plants and machinery for the treatment of ores. The course includes the determination of a practical process for treating a given ore, and the design for a mill for utilizing this process.

Prerequisites: Metallurgy 1w, 2w, and 31w, Shop Practice and Drawing 2w. To be accompanied by Metallurgy 33f.

Senior year, second term, six hours per week. Credit three hours.

36w. ORE DRESSING LABORATORY. (Mann)

The student becomes familiar with the operation and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

Prerequisites: Metallurgy 1w, 2w, and 33f. To be accompanied by Metallurgy 33w.

Senior year, second term, six hours per week. Credit three hours.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior Class take a three weeks' trip to Colorado and Utah, or other mining

districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students, to be signed by the mine or mill officials by whom he was employed, stating the time of such employment and nature of work.

Required of candidates for degrees of B. S. in Mining or Metallurgy.

Prerequisites: Mining 5w, Geology 3w, and Metallurgy 39w.

39w. GENERAL METALLURGY. *Lectures.* (Clayton)

This course is an introduction for the advanced metallurgical courses. The work is covered in a general way by the following headings: The properties of metals; the chemical equation from the standpoint of the metallurgist; methods of combustion; the temperature of combustion in any system and the effect thereon of certain variables; measurement of high temperatures; means of supplying oxygen for combustion, including stack design; metallurgical fuels and methods of firing, including a study of coals, coke, charcoal, gases from producers, and liquid fuels; calorimetry; refractories and their uses; types of furnaces and the reasoning involved in their design; a general study of typical metallurgical operations, including pyrometallurgical, hydrometallurgical and electrometallurgical processes; slags in general; conduction, radiation, and convection from the standpoint of the metallurgist. In this course much attention is given to the methods of attaching various metallurgical problems.

Prerequisites: Chemistry 3w and 4w, Geology and Mineralogy 1w.

Required in I., II. and VII.

Junior year, second term, three hours a week. Credit three hours.

Texts: Fulton, *Principles of Metallurgy.*
Hofman, *General Metallurgy.*
Richards, *Metallurgical Calculations.*
Burgess and Le Chatelier, *The Measurement of High Temperature.*

40w. JUNIOR METALLURGY LABORATORY.

(Clayton)

This course is intended for men following the metallurgy curriculum. It will take up in detail Pyrometry, Refractories, Fuel Testing, Gas Analysis, the Physical Properties of Metals, Cooling Curves, Roasting, Study of Slags, Use of the Microscope in Metallurgy and Ore Dressing, and Heat Conduction.

Prerequisites: To be accompanied by Metallurgy 39w.

Required in II.

Junior year, second term, three hours per week. Credit one and one-half hours.

41w. METALLURGY OF IRON AND STEEL. *Lectures.*

(Clayton)

This course is intended for those intending to follow metallurgy. It takes up in detail the study of iron and steel and the work follows these general headings: The properties of iron and its alloys and compounds; specifications for standard irons and steels; the ores of iron and the principles underlying their valuation; the preparation of iron ores for the blast-furnace; the iron blast-furnace, its construction and operation; the manufacture of pig iron; the properties of pig iron, and the factors upon which these properties depend; the calculation of furnace charges; the chemistry of the blast-furnace; the metallurgical operation of the blast-furnace; blowing engines; utilization of furnace gases; treatment of flue dust; heat balance of the operation of a blast-furnace; the manufacture of steels by the basic and acid bessemer, basic and acid open-hearth crucible, and electric furnace methods; the manufacture of wrought iron; the constitution and structure of iron and steel; heat and mechanical treatment of steel; foundry practice; uses of steel products; and the study of special steels.

Prerequisites: General Metallurgy 39f.

Required in II., V. and VI.

Junior year, second term, three hours a week. Credit three hours.

Texts: Stoughton, *Metallurgy of Iron and Steel.*
Sauveur, *Metallography of Iron and Steel.*
Carnegie, *Liquid Steel.*
Howe, *Iron, Steel, and Other Alloys.*
Richards, *Metallurgical Calculations, Vol. II.*

44w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This course is intended for men wishing to specialize in iron and steel.

Prerequisites: Chemistry 7f, Metallurgy 29w and 41w.

Senior year, second term, nine hours per week. Credit four and one-half hours.

46w. ORE DRESSING PROBLEMS. *Laboratory.* (Mann)

This covers a portion of the work given in Metallurgy 34b. It is intended for students wishing to spend a limited amount of time in mill designing.

Prerequisites: Metallurgy 1w, 2w and 33f.

Shop Practice and Drawing 2w. To be accompanied by Metallurgy 33f and 33w.

Senior year, second term, three hours per week. Credit one and one-half hours.

MILITARY SCIENCE AND TACTICS

MAJOR WILD, LIEUTENANT SHUTTLEWORTH.

By action of the Board of Curators instruction in military science is prescribed for all physically fit men in the Freshman and Sophomore classes. Participation by men in the Junior and Senior classes is voluntary.

January, 1919, by permission of the War Department, an Engineer unit, Senior Division, Reserve Officers' Training Corps was established at the Missouri School of Mines. The training is divided into two periods, the first covered by the Freshman and Sophomore years, with a summer camp at the termination of the first year and also at the termination of the second year, if individually practicable. The second period will consist of the Junior and Senior years with a second period at a summer camp at the termination of the Junior year and also of the Senior year if individually practicable.

Under Act of Congress of June 3, 1916, the Government furnishes uniforms, arms, ammunition, and special engineer equipment for the use of the military department, pays expenses of the summer camps and allows commutation of rations amounting to twelve dollars a month to those who take the third and fourth years of military training.

The cadet corps is organized as a battalion of two or more companies, and the cadet officers are selected, as far as possible, from the members of the two upper classes who have elected to take the advanced course.

The course as outlined has for its primary object the training of students in Engineering, so that, at the termination of their instruction, they will possess the following essential characteristics of a well-balanced junior officer of Engineers: (a) a good general education; (b) a good engineering education; (c) a well disciplined mind and body; (d) the basic training in Military Art. The first two characteristics are covered by the general courses in the college. The attainment of the third characteristic will be reached by the combination of training on the drill ground, lecture room, gymnasium, and summer camps. The fourth is covered by the purely military training, which is divided into two periods, the first being covered by the Freshman and Sophomore classes and taking three hours a week, the second by the two upper classes and taking five hours a week.

MILITARY 1.

Study of the I. D. R. and manual I. G. D., discipline, customs of the service, military courtesy, study of Small Arms Firing Manual, company administration. One hour a week first term, first year.

MILITARY 2.

Infantry Drill to include school of the soldier, squad and company, physical drill, games and "pep" instruction; preliminary instruction in sighting, position and aiming exercises; gallery practice, nomenclature and care of rifle and equipment. Two hours a week first term, first year.

MILITARY 3.

Theory of traget practice, use of landscape targets, map reading, study of small arms material, field service regulations, marches, outposts, camping, combat principles, sanitation, military hygiene. One hour a week, second term, first year.

MILITARY 4.

A continuation of military 2.

Two hours a week, second term, first year.

MILITARY 5.

Manual of Courts Martial, military law and history. One hour a week, first term, second year.

MILITARY 6.

Infantry Drill including school of company in close and extended order, bayonet drill, games and "pep" instruction. Two hours a week, first term, second year.

MILITARY 7.

Military law and history, tables of organization and equipment, field service regulations. One hour a week, second term, second year.

MILITARY 8.

Infantry drill, combat formation, bayonet drill, games and "pep" instruction.

Two hours a week, second term, second year.

Second Period.

During this period instruction will aim not only to teach the students themselves but also to teach them how to instruct others. To this end students will be given positions of responsibility at drills, and every opportunity will be taken to develop initiative, leadership, good judgment, and a sense of responsibility in them.

MINING

PROFESSOR FORBES, MR. BURKHART, MR. KROENLEIN.

The mining lecture room, located on the first floor of Norwood Hall in the southwest corner of the building, is provided with a combination lantern, reflectoscope and moving-picture machine. The school has several hundred lantern slides of mining scenes and mining machinery, and motion films showing mining operations are obtained from the U. S. Bureau of Mines. Three rock drills in section, supported on a suitable frame, are kept in the classroom together with exhibits of explosives, rock-drill bits, wire ropes, safety lamps, mine-rescue apparatus and various other mining appliances.

A number of models illustrating mining methods, head frames, mine timbering, skip dumps, reversible mine fan, methods of locating drill holes in tunneling and rotary drill for coal mining, are on display in the mining laboratory and are used in connection with the lecture work.

The surveying equipment, already referred to under Civil Engineering, includes a number of mining transits with auxiliary telescopes which are used for the field work in mine surveying.

Laboratories.

To meet the needs of some of the more important phases of mining work four laboratories have been equipped as follows:

Mine-Rescue and First-Aid Laboratory.

In accordance with the safety-first movement that has been making such rapid strides in the last few years, it has been deemed advisable to establish a mine-rescue and first-aid laboratory, where instruction is given in the use of breathing apparatus and in first aid to the injured. The equipment consists of three helmets, including a Draeger, Fleuss and Westfalia, a pulmotor, and all necessary first-aid supplies and charts. The time devoted to this laboratory does not exceed one afternoon a week for six weeks, but this is sufficient to familiarize the student with mine-rescue apparatus and to give him a fair knowledge of the principles of first aid.

In the Winter of 1919, the Mine Rescue and First-Aid work was given by the U. S. Bureau of Mines, from one of their Mine Rescue Cars, which was in Rolla for a period of two weeks.

METALLURGY AND ORE DRESSING BUILDING.

MINE TUNNEL.

Rock-Drilling Laboratory.

On account of the importance of rock drilling in metal mining operations, and also because it can readily be carried on in the laboratory, much stress is laid on this branch of the work, for which the following equipment is used: Piston drills; Ingersoll-Rand 2 1/4-inch auxiliary-arc-tappet drill; Ingersoll-Rand C-110 Butterfly; Sullivan 2 3/4-inch tappet; Sullivan 2 1/4-inch differential valve, with steam and air front heads; Sullivan FF-12 with water attachments; Wood 2 1/4-inch spool-valve. Hammer drills: No. 7 Water Leyner; Stopers: Waugh 16-V; Sullivan DA-21 with reverse feed; Hand Hammer drills: Ingersoll-Rand Jack-hammer; Hardsocg; Cleveland; Ft. Wayne electric drill.

This equipment has been purchased from time to time as improvements have been made by the manufacturers, and although not complete, embraces most of the different types of air drills in use at present.

For the work of drilling, large blocks of red granite about 4x4x5 feet are imported from Southeast Missouri. Two drilling frames for supporting the machines on column and arm have been constructed—one under cover in a frame building, and the other out of doors.

For sharpening steel, besides the usual hand tools, there is a Leyner-Ingersoll 5-A sharpener with a complete assortment of dies and dollies for forming various-shaped bits, including the cross, X, Z, bull, five-point, six-point, eight-point, high-center and single and double-chisel bits, as well as parts for shanking Leyner, Jack-hammer and piston steels.

The work done in this laboratory consists in sharpening steel both by hand and with the sharpener, and in drilling with the various machines. No attempt is made to drill a great number of holes, but the work consists in measuring cutting speeds with different bits and air pressures, noting variations in length and number of strokes under varying conditions and measuring air consumption. For this purpose a Sullivan air meter is used, and an electrical device designed at the school is used for counting the number of blows of the drills.

The amount of time spent in the laboratory does not exceed three hours a week or one laboratory period for one semester in the regular course, but much use is made of it in thesis and experimental work.

Compressed Air Laboratory.

The use of compressed air is so important in mining operations that the school has deemed it advisable to equip this laboratory

with apparatus that would be suitable not only for students' use, but also for purposes of research and investigation.

A Sullivan WB-2 straight-line air compressor of 290 cubic feet capacity supplies air for this laboratory as well as the rock-drilling laboratory, and a Laidlaw-Dunn-Gordon compressor, used by the school in pumping from a deep well, is in the same building and furnishes a different type for study.

Two large displacement tanks 15 feet high and 5 feet in diameter are used for making accurate measurements of air for the determination of orifice coefficients and various other experiments. Another interesting installation in this laboratory is a mine fan. This is a 36-inch single-inlet "Sirocco," directly connected to a 35 h. p. variable-speed motor, and has a capacity of 20,000 cubic feet per minute against a 4-inch water gauge. Two styles of runners with vanes at different angles are provided for experimental work. The fan is used in the regular laboratory work, where its efficiency is determined under varying conditions, and also for experimental work in air measurements, and the standardization of large orifices.

Mine Plant.

The mine plant is situated about one and one-half miles from the school, which was the nearest point available where rock of a suitable nature could be found. A tunnel is being driven into the hillside as shown in the engraving. The rock is a pitted dolomite.

The power plant for running the machine drills used in the tunnel consists of a 50 h. p. fire-tube boiler and an Imperial type 10 Ingersoll-Rand air compressor of 100 cubic feet capacity Water for the boiler is pumped from a nearby stream with a centrifugal pump driven by a 3 h. p. Ferro, two stroke per cycle, gasoline engine. A 5x7 Davis and Rankin steam engine and a 3.6 kw. 110-volt United States dynamo furnishes electricity for lighting the plant and for operating an electric drill. This unit has an interesting historical value. In 1892 it furnished all the power for the shop and for the dynamo laboratory, which were then located in the basement of the Rolla building.

In designing the power plant, an endeavor was made to introduce as great a variety of machinery as possible, as the operation of the plant is considered one of the most valuable features of this work.

The total time spent in the mine-plant laboratory is about the same as in the rock-drilling laboratory, but instead of working the usual three-hour period, from nine to twelve hours are put in at a time, as a three-hour period is entirely too short for this kind of work.

The work is largely experimental, and consists in using different explosives and analyzing their products of combustion; trying out

different methods of placing holes for blasting and different methods of setting off blasts; time studies of drilling operations are made, and cost-records of the work are required. In addition to this, the work of sharpening steel, timbering, mucking, track laying and hand drilling, together with the experience of running the power plant, affords a greater variety of work than can ordinarily be had in a reasonable length of time in practice. It is not the aim in this work to make drill runners or miners out of students, but to give them a greater familiarity with mining tools and methods than is obtainable from books or mere observation.

3f. MINING *Lectures.* (Forbes)

A study of rock excavation, including rock drilling, explosives and blasting, supporting excavations, tunneling and shaft-sinking. Written reports are required on each subject as completed.

Prerequisites: Mechanical Drawing 2w, Physics 1w.

Required in I. and III.

Junior year, first term, three hours per week. Credit three hours.

Texts: Peele, *Mining Engineers' Handbook.*
Current Technical Journals.
Publications of U. S. Bureau of Mines.

5w. MINE SURVEYING. *Lectures.* (Burkhardt)

The theory and practice of mine surveying are presented by lectures. The methods of carrying azimuth underground under different conditions are studied in detail, including shaft plumbing and the use of the auxiliary telescope. Notes of a complete mine survey are given the students, from which all calculations must be made and maps drawn. Other problems involving the strike and dip of veins are introduced, including the determination of intersection of veins, length of tunnels to interest veins at depth, and the determination of strike, dip and thickness of veins from bore-hole data.

Prerequisite: Civil Engineering 2f.

Required in I.

Junior year, second term, two hours per week. Credit two hours.

Text: Durham, *Mine Surveying.*

6w. MINE SURVEYING. *Problems.* (Burkhardt)

One afternoon per week is devoted to the solution of problems in mine surveying and to making mine maps.

Prerequisite: Must be accompanied by Mining 5w.

Required in I.

Junior year, second term, three hours per week. Credit one and one-half hours.

11w. MINING. *Lectures.* (Forbes)

This is a continuation of the work of the Junior year, and includes the study of mining methods, sampling and estimation of ores, mine valuation, and a study of mining costs. The principles of mining law are also reviewed.

Prerequisites: Mining 3f, Geology 9f.

Required in I.

Senior year, second term, three hours per week. Credit three hours.

Candidates for the degree of Bachelor of Science in Mine Engineering or in Metallurgy, taking this course, must also take Senior Trip.

Students taking this course who do not take course 12, will be given special work while the remainder of the class is taking the Senior Trip.

Texts: Hoover, *Principles of Mining.*
Finlay, *The Cost of Mining.*
Peele, *Mining Engineers' Handbook.*
Current Technical Journals.

12. SENIOR TRIP.

During the second semester of the Senior year, a two weeks' trip is taken to Joplin or to St. Louis, Flat River, and other points in the southeast Missouri lead district, for the purposes of studying mining, ore dressing, smelting, geology, and power plants of these districts. Several days are devoted to practical work in mine surveying during which time a complete survey and map of some portion of a mine is made.

Required for graduation in Curriculum I.

13w. MINE VENTILATION. *Lectures.* (Forbes)

A study of the various gases met with in mines, their origin, effects and detection; the amount of fresh air required for men and animals under varying conditions; natural and artificial means of ventilation; gas and dust explosions, and mine-rescue work. A large part of the course is devoted to problems in mine ventilation.

Prerequisites: Mining 3f and Physics 3f.

Senior year, first term, three hours per week. Credit three hours.

Not given in 1918-19.

16f. MINING LABORATORY. (Kroenlien)

Laboratory work in rock drilling and blasting, timbering, sharpening steel, track-laying, and operation of mine power plants. Reports are required on all work. A study of mine-rescue apparatus and first aid to the injured is included in this course.

No credit will be allowed in mining laboratory except in Curriculum I.

Prerequisite: Must be accompanied by Mining 3f.

Required in I.

Junior year, first term, three hours per week. Credit one and one-half hours.

16w. MINING LABORATORY. (Forbes)

A continuation of the laboratory work of the Junior year. A feature of this work is the keeping of accounts and cost records of tunnel driving as a training in the study of mine accounting.

No credit will be allowed in mining laboratory except in Curriculum I.

Prerequisites: Mining 3f, 16f; Civil Engineering 27f; must be accompanied by Mining 17f.

Senior year, second term, three hours per week. Credit one and one-half hours.

17w. MINING CONFERENCE. *Lectures.* (Forbes)

The conference consists in discussions relative to the mining laboratory work and lectures on mine accounting and bookkeeping. Reports are prepared by the student on various assigned subjects and presented to the class.

Prerequisites: Must be accompanied by Mining 16w.

Senior year, second term, one hour per week. Credit one hour.

19w. MINING ECONOMICS. *Lectures.* (Forbes)

Various economic problems of interest to mining engineers are studied. The influence of mining in the history of America and especially in United States history is reviewed and the relation of mining to other industries is considered. The organization of the mining industry, the conservation of the mineral resources, and various problems in economics, including mining labor, wages, capital, taxation, profit-sharing, and employers' liability are presented by lectures and assigned reading.

Prerequisites: Mining 11w, Geology 9f.

Graduate course, first term, one hour per week. Credit one hour.

Not given in 1918-19.

20f, 20w. MINE PLANT DESIGN. *Laboratory.* (Forbes)

This is a drafting-room course and is supplementary to all the previous mining courses. Each student is required to prepare complete drawings for the equipment of a given mine. Bills of material, specifications, and complete estimates are submitted.

Prerequisites: Mining 11w and Civil Engineering 15f.

Graduate course, first and second terms, six hours per week. Credit six hours.

23f. MINING LAW. *Lectures.* (Forbes)

A study of the mineral land laws of the United States and laws affecting the operation of mines, including workmen's compensation acts.

Prerequisites: Completion of the Junior year in Curriculum I.

Senior year, first term, one hour per week. Credit one hour.

25w. OIL AND GAS. *Lectures.* (Forbes)

A study of well-drilling and oil-production methods.

Prerequisite: Geology 17f.

Senior year, second semester, one hour per week. Credit one hour.

Text: Paine and Stroud, *Oil Production Methods.*

Not given in 1918-19.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior Class take a three weeks' trip to Colorado and Utah, or other mining districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students, to be signed by the mine or mill officials by whom he was employed, stating the time of such employment and nature of work.

Required of candidates for degrees of B. S. in Mining or Metallurgy.

Prerequisites: Mining 5w, Geology 3w, and Metallurgy 39w.

PHYSICS AND ELECTRICAL ENGINEERING

PROFESSOR McRAE, ASSOCIATE PROFESSOR GARRETT, ASSISTANT PROFESSOR WALLIS, MR. FRAME*, MR. SCHAPPLER.

Equipment.

The lecture room and laboratories for Physics and Electricity are in Norwood Hall. The lecture room will seat one hundred students and is provided with water, gas, and electric connections for conveniences in lecture demonstrations and experiments.

The physical laboratory is on the ground, or basement, floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound, and heat, and one equipped for electric measurements. There is a battery room equipped with both primary and secondary batteries connected by wire with the various laboratories and the lecture room; a constant-temperature room with double walls and air space insulation; a commodious dark-room with blackened walls for spectrometric and photometric measurements, and a special laboratory for research work.

The equipment includes a Rowland electro-dynamometer with shunts and resistances; a Leeds and Northrup standard potentiometer with shunts and voltage coils; a Leeds and Northrup decade wheatstone bridge; a Queen post office pattern wheatstone bridge; a Leeds and Northrup ohmmeter; various wheatstone bridges and resistance boxes; standards of resistance and inductance; paper and mica condensers; various tangent, mirror, and ballistic galvanometers; a Duddell thermo-galvanometer; a Dolezalek quadrant electrometer; a Lummer-Brodhun photometer; a Bunsen photometer; a Gaetner dividing engine with linear and circular attachments; a Threlfall micro-manometer; a Dietzgen anemometer; a ten-inch induction coil; Crookes tubes; cathode and X-ray tubes; a Van Hooten and Tenbroeck electrostatic machine; a wireless demonstration set; a Gaetner electroscope for radio-active measurements; a Schmidt & Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; an Ives photograph of a Rowland grating; various balances; calorimeters;

*On leave of absence.

micrometers, calipers, together with apparatus for illustrating the principles of physics.

The steam laboratory equipment includes Parr and Roland-Wild coal calorimeters; Ellison throttling and evaporating moisture calorimeter; Peabody, and Schaeffer and Budenberg moisture Calorimeters; General Electric Co., and Gebhart portable steam flow meters; Hays, and Orsat flue gas apparatus; Crosby, Thompson, Robertson, Schaeffer and Budenberg, and American steam and gas engine indicators; Schaeffer and Budenberg continuous drum indicator; Amsler, Willis, and Keuffel and Esser planimeters; various indicating and recording steam gages; Crosby steam gage tester; Tycos portable pyrometer; three water meters; thermometers, manometers, tachometers, and speed counters; Prony end friction brakes.

The dynamo laboratory contains an assortment of direct current generators and motors, a General Electric double current generator for direct current and alternating current work, a single and a three-phase generator, an induction motor, a single-phase repulsion motor, a rotary converter, stationary transformers, three-phase to two-phase transformers, Cooper-Hewitt mercury converters, a General Electric electrolytic motor-generator set, a remote control starting box, testing instruments, which include a Weston laboratory standard voltmeter with multipliers; a Weston laboratory standard millivoltmeter with shunts; Kelvine lectrostatic stationary and portable voltmeters; Weston portable ammeters and voltmeters; Weston portable milli-voltmeters with shunts, and milli-ammeters with resistances; Weston, Thomson, and Westinghouse portable direct current and alternating current voltmeters; Weston and Thomson portable watt meters; Westinghouse portable poly-phase wattmeter; Westinghouse portable single and poly-phase watt-hour meters; Westinghouse portable voltmeters and ammeters with transformers; General Electric edgewise type alternating current voltmeters, ammeters and watt-hour meters, electrodynamometers; Grassot fluxmeter; portable resistance grids, inductance coils, and condensers.

The various electrical motors used for power purposes in the shops and laboratories are available for testing in addition to the machinery in the dynamo laboratory. The total electrical equipment includes thirty-five motors, varying in size from ½ h. p. to 35 h. p., with the aggregate rating of 225 h. p.

The power plant is also used for experimental purposes, and comprises a strictly modern and thoroughly equipped laboratory. The machinery available for testing purposes includes four 130-h. p. Heine safety boilers, one of which is especially equipped with openings in the setting for temperature and draft measurements in furnace, combustion chamber and flues; a 13 by 14 Erie Ball engine direct connected to a 75 kw. 220 volt D. C. Westinghouse

generator; a 10 by 12 Ideal engine direct connected to a 50 kw. 220 volt D. C. Westinghouse generator; a 12 by 11 General Electric marine type engine direct connected to a 50 k. v. a. 220 volt, 60 cycle, three-phase generator with direct connected exciter; a 10 kw. 220 volt Curtis steam turbo generator; a 9 by 14 Brownell engine equipped with a rope friction brake; a 5 by 7 Davis and Rankin vertical engine equipped with a Prony brake; a 21-h. p. Otto four strokes per cycle gas engine belted to a General Electric 15 kw. 220 volt D. C. inter-pole generator, and to a two stage Worthington centrifugal pump; a 3-h. p. Ferro two strokes per cycle portable gas engine; a D. C. switchboard with a penal for each generator and two for distribution switches, equipped with a Tirrill voltage regulator, a Thomson recording watt-hour meter, circuit breakers for each generator, and the usual ammeters and voltmeter; an A. C. switchboard with voltmeter, ammeters, wattmeter, and watt-hour meter. The pneumatic equipment includes a Laidlow-Gunn-Gordon air compressor, a Rand Imperial air compressor, a Sullivan straight-line two-stage air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, a 60-inch Buffalo forge blower, an experimental fan capable of delivering 250 cu. ft. of air per second at six inches of water pressure, two cylindrical steel tanks 6 ft. by 15 ft. for measuring air by water displacement.

There is a complete steam and pumping plant at the experimental mine, where laboratory practice is also obtained.

Courses.

1f. GENERAL PHYSICS. *Lectures.* (Garrett)

The work in general physics begins with the study of kinematics, statics, kinetics, and the mechanics of fluids. The term's work concludes with the study of heat, including an introduction to thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of such subjects as sound, light, and alternating currents of electricity.

Prerequisites: To be preceded by or accompanied by Mathematics 9f, 11f and 11w.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first term, three hours per week. Credit three hours.

Text: Spinney, *A Textbook of Physics.*

2f. GENERAL PHYSICS. *Laboratory.* (McRae)

The laboratory is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured.

Emphasis is laid upon the derivation of physical laws rather than the verification of them.

Prerequisite: Mathematics 7w, and must be preceded or accompanied by 1f.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first term, three hours per week. Credit one and one-half hours.

3w. GENERAL PHYSICS. *Lectures.* (McRae)

This is a continuation of course 1w and includes the study of electricity and magnetism, sound and light. Particular stress is laid upon electrical potential, resistance, and impedance, and upon the reflection, refraction, and interference of waves. Lectures, illustrated by experiments, and recitations.

Prerequisites: To be preceded by or accompanied by Mathematics 9f and 11f. Physics 1f.

Required in I., II., III., V., VI. and VII.

Sophomore year, second term, three hours per week. Credit three hours.

Text: Spinney, *A Textbook of Physics.*

4w. GENERAL PHYSICS. *Laboratory.* (McRae, Schappler)

The work in the laboratory deals with the subjects studied in Physics 3w and the method is the same as that outlined in Physics 2f.

Prerequisite: Must be preceded or accompanied by Physics 3w.

Required in I., II., III., V., VI. and VII.

Sophomore year, second term, three hours per week. Credit one and one-half hours.

7f, 7w. PRINCIPLES AND PRACTICE OF ELECTRICAL ENGINEERING. *Lectures.* (Wallis)

This course discusses the magnetic circuit of dynamos and motors, methods of testing and connections for operation of direct current dynamos and motors, of single and polyphase alternating current generators, of induction and synchronous motors, of stationary transformers and rotary converters, and the effects of frequency, resistance, inductance and capacity upon the impedance of alternating current circuits. During the latter part of the course the design of electrical transmission lines is studied, accompanied by the analytical and graphical solution of practical problems.

Prerequisites: Physics 1f and 3w.

Senior year, elective, first and second terms, three hours per week. Credit three hours.

Texts: Gray, *Principles and Practice of Electrical Engineering.*
Pender, *Principles of Electrical Engineering.*

8f, 8w. DYNAMO LABORATORY. (McRae)

This course accompanies course 7f, 7w, and consists of calibration of instruments, measurements of ohmic and reactive resistances, insulation resistance and dielectric strength, regulation and efficiency tests, of dynamos, motors, transformers, and converters.

Prerequisites: Physics 1f and 3w.

Senior year, elective, first and second terms, three hours per week. Credit one and one-half hours each semester.

9f, 9w. ELECTRICITY AND MAGNETISM. (Frame)

This course is designed as an introduction to the study of electricity and magnetism.

Prerequisite: Mathematics 3f.

Elective, first term, lectures and recitations, five hours per week. Credit five hours.

Second semester, four recitations per week. Credit four hours.

Text: Timbie, *Elements of Electricity.*

Not given in 1918-19.

10w. ELECTRICAL LABORATORY. (McRae)

This course includes elementary tests in electrical and magnetic circuits, measurements with ammeters, voltmeters and wattmeters, and practice in wiring, connecting up lamps, motors and transformers.

Prerequisite: Physics 3w or 9f.

Sophomore year, second term, six hours per week. Credit three hours.

11f. 11w. ELECTRICAL MACHINERY. *Lectures.*

(Frame)

During the first semester this course takes up a detailed discussion of armature windings. The second semester is given to the study of various types of control apparatus.

Prerequisites: Physics, 3w and 4w.

Required in V.

Senior year, first and second term, two hours per week. Credit four hours.

Not given in 1918-19.

12f, 12w. ELECTRICAL MACHINERY LABORATORY.

(Frame)

This course accompanies 11f, and 11w, and consists of practice in armature winding and a study of control apparatus.

Prerequisites: Physics 3f and 4f.

Required in V.

Senior year, first and second terms, three hours per week. Credit three hours.

Not given in 1918-19.

13f, 13w. ALTERNATING CURRENTS.

A continuation of Physics 7w and includes a rigorous analytical treatment of the subject as well as a study of the various practical applications in mining and metallurgy.

Prerequisites: Physics 7w and 8w.

Elective, first and second terms, five hours per week. Credit ten hours.

Text: D. C. and J. P. Jackson, *Alternating Currents and A. C. Machinery.*

Not given in 1918-19.

19w. ELECTRIC DISTRIBUTION.

This course brings before the student problems of location of power house, size of conductors and transformers, lightning arresters, costs of systems and wiring for lights and power.

Prerequisites: Physics 7f and 7w.

Required in VI.

Senior year, second term, three hours per week. Credit three hours.

Not given in 1918-19.

21f. ELECTRIC RAILWAYS.

The railway motor and auxiliaries; train performance; interurban railways, signal service; and estimated costs of the different parts of the system are gone into in this course.

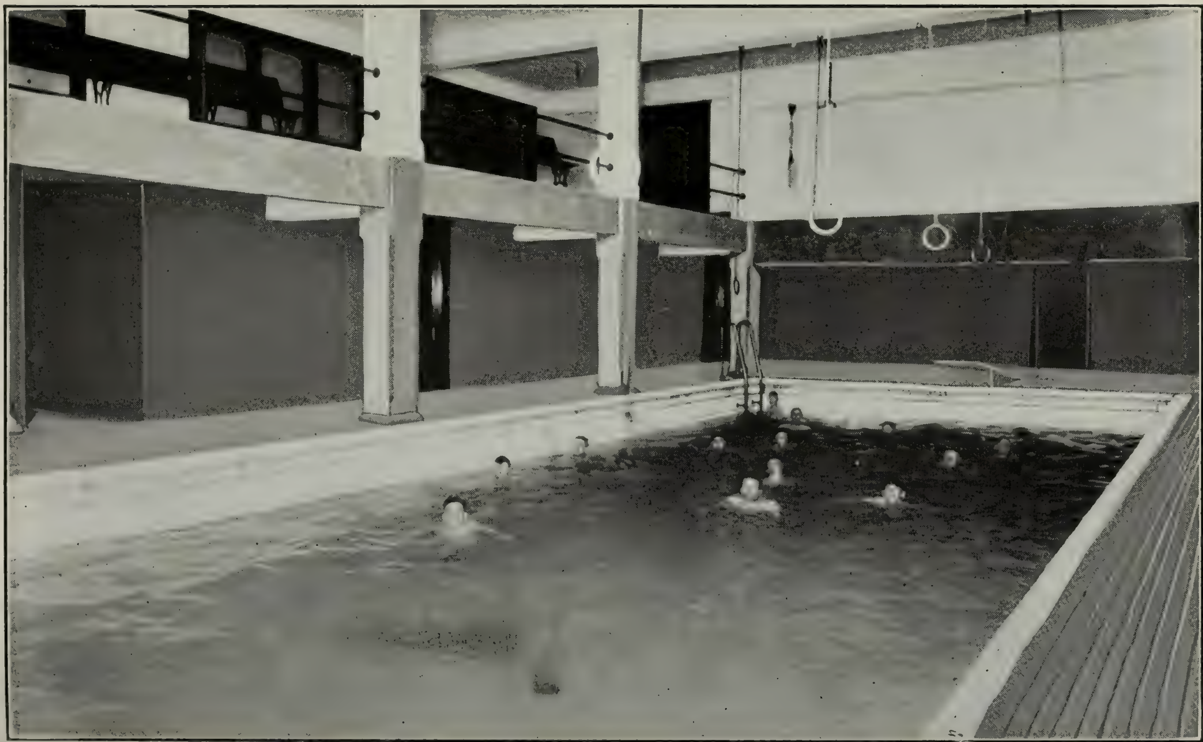
Prerequisites: Physics 7f and 12w.

Required in V.

Senior year, second term, five hours per week. Credit five hours.

Not given in 1918-19.

GYMNASIUM.



SWIMMING POOL.

PHYSICAL TRAINING.

MR. SERMON, MR. SWAYZE.

For the physical training of students excellent opportunities re offered by the Jackling Gymnasium and the Jackling Field. The former, completed in 1915, at a cost of seventy thousand dollars, is a strictly modern fireproof building and is equipped with baths, dressing rooms, lockers, a swimming pool 20 feet wide and 60 feet long and various kinds of apparatus and game courts usually found in modern gymnasiums. Class work, consisting of setting-up exercises, developing exercises, calisthenics, the use of dumb-bells, clubs, and wands is given under the supervision of the Director of Physical Training. The aim of this work being to develop health, strength and vitality.

Jackling Field, constructed in 1909, by virtue of a gift of Mr. D. C. Jackling, '92, adjoins the gymnasium and provides a football gridiron, a baseball diamond, and a quarter-mile running track for class and intercollegiate games and events. A number of tennis courts about the campus are maintained in good order. Golf links near the campus are maintained for the benefit of the students.

The School encourages rational athletics and a participation in intra and intercollegiate sport, all branches of which are under the direct supervision of the Director of Physical Training and management of the Board of Control. The membership of the Board of Control consists of the Director of Physical Training, the Chairman of the Faculty Committee on Athletics, the President of the Athletic Association, and the Secretary of the Executive Committee of the Board of Curators as ex-officio treasurer.

The personnel of the Board of Control for 1918-19.

Mr. Sermon, Dr. Cox, Mr. Swayze and Mr. Kahlbaum.

EXCURSIONS

During the summer the members of the Junior class are given the option of engaging in practical work at some mine, mill or smelter, or of making a trip to Colorado and Utah. The itinerary of this trip includes Denver, Idaho Springs, Central City, Georgetown, Silver Plume, Montezuma, Breckenridge, Leadville, Colorado Springs, Cripple Creek, Victor, and Pueblo in Colorado, and Salt Lake City, Garfield, and Bingham in Utah. Special attention is given to mining practice in the Clear Creek District, the Cripple Creek District, and Leadville and vicinity. Amalgamation is studied in the Clear Creek District, cyanidation at Colorado Springs and Victor; smelting of gold, silver, copper, and lead ores at Leadville and Pueblo; iron and steel metallurgy at Pueblo; treatment of zinc ores at Leadville.

During the Senior year a trip is made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast-furnace practice. Here may be studied the blast-furnace, regenerative stoves, blowing machinery, power plant, and other appliances necessary for the production of pig iron. Open-hearth steel methods and the manufacture of steel castings are studied at the plant of the Scullin Steel Co. This plant includes, in addition to the usual type of open-hearth furnace, Bessemer converters, cupolas, and gas-producers.

The metallurgy of zinc is studied at various plants, where the roasting of blende and distillation methods may be seen. The Federal Smelter, at Alton, is visited for the study of lead smelting. At this plant the lead blast-furnace, the Huntington-Heberlin roasting system, and the Scotch ore-hearths are carefully inspected. This plant also includes an extensive bag house. The manufacture of white-lead paint and of lead pipe is seen at the National Lead Works. A further study of lead smelting is made at Herculaneum, where blast furnaces are served by Dwight-Lloyd roasters. At the various plants enumerated, particular attention is paid to construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Company. This plant is one of the largest clay manufacturing works in the world and a metallurgist here has a splendid

opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

The class visits Southeast Missouri to study the geology, methods of mining, and the milling of great disseminated lead deposits. The geological work of this trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernible in relation to the contact plane between the pre-Cambrian and the Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain give interesting study in the distribution and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rock in conjunction with jointing and stratification is well illustrated.

The concentration plants of Southeast Missouri are large and modern, containing crushers, rolls, elevating machinery, jigs, Wilfley tables, flotation installations and sundry other machines. The mining plants are thoroughly modern and include steam and electric hoists, modern steel head-frames, compressed air and electric haulage, extensive pumping plants, and numerous diamond-drill prospecting equipments.

An optional trip is given to Southwest Missouri for the purpose of studying the geology, mining and milling of the shallow deposits of zinc ores and the "sheet" ground mines. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electrical power to mining and milling is well illustrated in this district. Short trips are made to neighboring camps in Southwestern Kansas.

The students interested in coal mining are given an opportunity on the Senior trip, to visit several of the large Illinois coal mines, in the vicinity of St. Louis, for the purpose of studying the up-to-date plants and modern methods in use in this district.

Practical work in mine surveying is a part of the Senior trip, and one week's time is devoted to the survey of a mine in the Southeast Missouri district or in the Illinois coal field. A complete survey and map of a portion of a mine is made during this time.

GENERAL INFORMATION

Fraternities.

There are five Greek-letter college fraternities, each maintaining a chapter house: Gamma XI of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha and Alpha Delta Zeta of Lambda Chi Alpha.

The engineering scholarship fraternity, Tau Beta Pi, established its Missouri Beta chapter in the School in 1908; and in 1916 the professional engineering fraternity, Theta Tau, installed its Iota chapter.

Y. M. C. A.

The organization stands for the best there is in college life and brings together those who believe that college men should develop well-rounded characters, physical, mental, and spiritual. During the opening days of the college the members of the Association devote themselves to the very practical service of meeting new men at the trains, helping them to secure living quarters, and aiding them in getting a good start in school. The Association occupies commodious and well-appointed quarters on the first floor of Parker Hall, where all students are welcomed and where the regular meetings are held.

The Officers of the Association for 1918-1919 are:

J. R. Stubbins, '20 .... *President.*
G. F. Rackett, '20 .... *Secretary.*
M. H. Thornberry .... *Faculty Adviser.*

The Missouri Mining Association.

The objects of the Mining Association are: To advance the knowledge of mining among its members; to promote good fellowship among the students and alumni of the School of Mines and others interested in mining; and to bring the School into closer relation with the mining profession at large. Students in the School of Mines who have sixty-three credit hours on their course and alumni are eligible to membership.

This association is affiliated with the American Institute of Mining Engineers, and any member of it may become a junior member of the Institute. Such membership carries with it most

of the privileges of regular membership at about one-half of the cost and with no initiation fee.

Officers of the Association for the year 1917-1918 are:

G. F. Rackett, '20 . . . . *President.*
H. H. Hoppock, '20 . . . . *Secretary-Treasurer.*

Metallurgical and Chemical Society.

The Society meets fortnightly for the consideration and discussion of addresses, lectures, and informal talks on metallurgical and chemical topics,—theoretical, practical, and industrial,—delivered by students, faculty, and visiting professional men.

Students of metallurgy or chemistry with at least forty-three hours credit are eligible as active members; other students having forty-three hours credit or more may become associates.

The officers for 1918-1919 are:

P. D. Wilkinson, '19 . . . . *President.*
E. A. Slover, '20 . . . . *Vice-President.*
R. O. Swayze, '20 . . . . *Secretary-Treasurer.*

Student Council.

The Student Council has for its object the promotion of various student enterprises and activities, and the maintenance of a spirit of mutual confidence in the student body and the faculty. The Council is composed of three Seniors and two Juniors, selected by the entire student body.

The Members of the Council for 1918-1919 are:

J. M. Morris, '19
W. E. Oyler, '19
J. W. Scott, '19
G. F. Rackett, '20
F. W. Uthoff, '20

Athletic Association.

The object of the Association is to unite the various efforts of the School in athletic sports. All students pay an athletic fee of five dollars a semester, which entitles them to membership in the Athletic Association, to admission to all athletic contests held under the auspices of the Athletic Association, and to golf club and gymnasium privileges. Members of the Faculty may become members of the Association by the payment of the stipulated fee. The Association elects its own officers and has general charge of all school athletics. The financial affairs of the Association are handled by a Board of Control. See page 132.

The Officers of the Association for 1918-1919 are:

R. O. Swayze, '20 . . . . *President.*
J. L. Howendobler, '20 . . . . *Vice-President.*
R. J. Dowd, '19 . . . . *Secretary.*
H. H. Hoppock, '20 . . . . *Business Manager.*
F. H. Taylor, '20 . . . . *Cheer Leader.*
E. J. Hollow, '20 . . . . *Cheer Leader.*

The Rollamo.

The Rollamo, first published in 1907 by the fraternities, is now edited by a staff chosen from the entire student body. The publication is the official yearbook of the school, and chronicles in permanent form the activities of the school year.

The Board for 1918-1919 consists of the following:

F. W. Uthoff, '20 . . . . *Editor-in-Chief.*
C. A. Gettler, '20 . . . . *Associate Editor.*
C. B. Hummel, '20 . . . . *Associate Editor.*
W. J. Nolte, '19 . . . . *Art Editor.*
A. H. Petsch, '19 . . . . *Athletic Editor.*
K. M. Wright, '20 . . . . *Secretary.*
B. G. Nichols, '19 . . . . *Business Manager.*
E. G. Hollow, '20 . . . . *Asst. Business Manager.*

The Missouri Miner.

The Missouri Miner is a weekly publication and was established in 1914-1915. It records the news of each week of interest to the student body and to the Alumni. It has been adopted as the official organ of the Alumni Association.

Staff for 1918-19.

Editorial.

James P. Gill . . . . *Editor-in-Chief.*
W. Scott . . . . *Associate Editor.*
G. Rackett . . . . *Assistant Editor.*
Huston Taylor . . . . *Assistant Editor.*
R. N. Stubbs . . . . *Assistant Editor.*

Business Management.

R. K. Stroup . . . . *Business Manager.*
K. W. Booker . . . . *Asst. Business Manager.*
Allan Potts . . . . *Asst. Business Manager.*
P. D. Wilkinson . . . . *Advertising Manager.*
H. Kerr . . . . *Asst. Adv. Manager.*
W. F. Netzeband . . . . *Circulation Manager.*
W. R. Luckfield . . . . *Asst. Circulation Mgr.*

Class Reporters.

Charles Schnaidt. . . . . *Senior Class.*
Edwin Schuman. . . . . *Junior Class.*
H. O. Norville. . . . . *Sophomore Class.*
Homer Leonard. . . . . *Freshman Class.*

EXPENSES

Tuition Fee.

Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after January 1, 1909, non-residents of Missouri who matriculate in any Department of the University be required to pay a tuition fee of $20.00 per year."

Laboratory Fees.

The fees charged are as follows: An incidental and library fee of $5.00 a year, payable upon entrance; a laboratory fee in general chemistry to cover the cost of gas and supplies, $5.00 a term; a laboratory fee in qualitative analysis of $10.00 a term to cover the cost of general supplies and gas; a laboratory fee for quantitative analysis and Senior and Junior chemistry laboratory courses, $2.00 a term; a fee of $2.50 a term to cover the cost of fuel and supplies in forge work; a fee of $2.50 a term to cover supplies in machine shop; a fee of $25.00 a term, $18.00 a term or $10.00 a term to cover the cost of supplies and fuel in the assay laboratory; a fee of $5.00 a term for metallurgical laboratory; a fee of $4.50 a term for mineralogy laboratory; a fee of $5.00 a term for materials laboratory; a fee of $2.50 for diploma; a gymnasium and athletic fee of $5.00 a term.

Excursion Expenses.

The cost of field excursions will average about $50.00 a year. The total expenses of all trips in the four-year mining curriculum is about $200.00.

Contingent Deposits.

A deposit of $15.00 is required from each student to cover the cost of extra supplies and damage to apparatus. This deposit must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Annual Expenses.

The following is an estimate of the heaviest items of the student's expenses. As personal tastes vary widely, no estimate of total expenses is offered:

Room rent, eight months, \$5.00 to \$10.00 per month, average	\$65.00
Board, thirty-two weeks, \$5.00 per week, average	160.00
Fees, excluding tuition	55.00
Drawing instruments (first year) and books	25.00

JACKLING LOAN FUND

Loans may be made to students of the School of Mines from the Jackling Loan Fund under the following conditions:

1. The student must have been in attendance at the School of Mines one semester.

2. Written requests for loans must be filed with the Director to be considered at the following meeting of the Executive Committee.

The parent or guardian must sign the note with the student.

4. No loans of more than one hundred dollars may be made to any one student during the calendar year.

5. The student shall give his note for the amount of the loan, which note shall bear interest at the rate of five per cent per annum from the date of the note to one year after his graduation or his leaving the School of Mines, and for one year following at the rate of eight per cent per annum. The note shall then become due.

The purpose of the Jackling Loan Fund is to help worthy students who require financial assistance and who are unable to borrow money from other sources.

THE MINING EXPERIMENT STATION

Officers of the Station.

Albert Ross Hill, Ph. D., LL. D. . *President of the University.*
Austin Lee McRae, S. D . . . . *Director.*
Guy Henry Cox, Ph. D., E. M . . . . *Geology and Mineralogy.*
Carroll Ralph Forbes, E. M. . . . . *Mining.*
William DeGarmo Turner, Ph. D . *Chemistry.*
Horace Tharp Mann, E. M. . . . . . . *Metallurgy and Ore Dressing.*
Martin Harmon Thornberry, B. S. *Research Assistant.*

The Mining Experiment Station was established June 1, 1909.

It is the object of the Station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters; to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and metallurgical engineering to the mineral industry of the State of Missouri.

The following bulletins were issued during the year:

Bibliography of Roasting, Leaching, Smelting and Electrometallurgy of Zinc, by H. L. Wheeler.

An Investigation of Blended Portland Cement, by E. S. McCandliss and H. H. Armsby.

The Effect of Addition Agents in Flotation, M. H. Thornberry and H. T. Mann.

Preliminary Studies of Missouri Cannel Coal, by H. L. Dunlap.

The Experiment Station is now working in co-operation with the State Geological Survey and the National Bureau of Mines on the milling and concentration of Missouri lead and zinc ores.

Any resident of the State may on request obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Correspondence regarding these bulletins or the work of the Station may be addressed to the Director, Mining Experiment Station, Rolla, Missouri.

BUREAU OF GEOLOGY AND MINES

The Geological Survey of the State of Missouri has its headquarters at Rolla, and occupies the Rolla Building on the School campus.

Board of Managers.

GOVERNOR FREDERICK D. GARDNER, Jefferson City,
President.

ELIAS S. GATCH, St. Louis,
Vice-President.

CLARK CRAYCROFT, Joplin,
Secretary.

EDWARD M. SHEPARD, Springfield,
Chairman of Publication Committee.

PHILIP N. MOORE, St. Louis.

Staff of the Geological Survey.

H. A. BUEHLER,
State Geologist.

M. E. WILSON,
Assistant State Geologist.

Equipment and Investigations.

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects, and a museum of seven thousand specimens of clay coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri.

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of geology to the ore deposits is also worked out and detailed reports published concerning such investigations.

The Department has the following reports available for distribution at the present time:

Preliminary Report	Vol. XIII.
Geology of Miller County	Vol. I., 2d series.
Quarrying Industry of Missouri	Vol. II., 2d series.
Geology of Moniteau County	Vol. III., 2d series.
Geology of the Granby Area	Vol. IV., 2d series.
Public Roads	Vol. V., 2d series.
Lime and Cement Resources of Missouri	Vol. VI., 2d series.
Geology of Morgan County	Vol. VII., 2d series.
Geology of Pike County	Vol. VIII., 2d series.
Geology of the disseminated Lead Deposits of St. Francois and Washington Counties	Vol. IX., 2d series.
Iron Ores of Missouri	Vol. X., 2d series.
Coal Deposits of Missouri	Vol. XI., 2d series.
Geology of the Rolla Quadrangle	Vol. XII., 2d series.
The Stratigraphy of the Pennsylvanian Series of Missouri	Vol. XIII., 2d series.

DEGREES CONFERRED IN 1918

Commencement Exercises May 24, 1918.

Engineer of Mines.

William Coryell Hogoboom, B. S. 1914

Colwell Arba Pierce, B. S. 1916

Donald Hewson Radcliffe, B. S. 1913

Metallurgical Engineer.

Joseph Cooper Finagin, Jr., B. S. 1914

Herbert Russell Hanley, B. S. 1901

Bachelor of Science in Mine Engineering.

Raoul Chavez

Francis Hodgson Geib

Oscar Gotsch

Te Chun Hoo

Earl Ross Housholder

Harry Albert Kluge

Orie Newell Maness

William Houston Reber

LeRoy Robert Scheurer

Raymond Samuel Weimer

Lawrence Joseph Zoller

Bachelor of Science in Metallurgy.

Howell Smith Clark

Henry William Doennecke

James Pressley Gill

Tony Frank Golick

Knud Fabricius Hansen

James Willard Pugh

Michael Wayne Shanfeld

Horace Reynolds Stahl

Hanley Weiser

Bachelor of Science in Civil Engineering.

Walter Charles Zeuch

Edgar C. M. Burkhart

Bachelor of Science in General Science.

Eldred Dewey Wilson

Bachelor of Science in Mechanical Engineering.

George Edward Mellow

STUDENTS SUMMER SESSION 1918

Ahrens, Herbert Emmett . . . . *Corning, Mo.*
Albert, Hyman Isidore . . . . *St. Louis, Mo.*
Ashlock, Evan Earl . . . . *St. Louis, Mo.*
Davison, Lewis Ely . . . . *Savannah, Mo.*
Dreidel, Eugene . . . . *St. Louis, Mo.*
Hodges, Isaac Franklin . . . . *Granby, Mo.*
Hughes, Harry Herbert . . . . *Wichita, Kan.*
Kershner, Karl Kenneth . . . . *St. Louis, Mo.*
Millar, Charles James . . . . *Webb City, Mo.*
Moore, Robert Douglass . . . . *Carthage, Mo.*
Wright, Kenneth Maurice . . . . *Kansas City, Mo.*

STUDENTS 1918-19

GRADUATE STUDENTS

Gill, James Pressley, B. S., '18 .... *Montgomery City, Mo.*
Hansen, Knud Fabricius, B. S., '18 .. *Copenhagen, Denmark.*
*Horner, Preston King, B. S., '06 ..... *Katanga, Africa.*
*McNely, Earl Joesting, B. S., '16 .... *Alton, Ill.*
*Metz, Gilbert Frank, B. S., '14 ...... *Hannibal, Mo.*
*Peterson, Clarence Eugene, B. S., '16. *Brooklyn, N. Y.*
*Wilson, Frank, Lewis Leonard '08 .... *Huntington, W. Va.*

SENIORS

MINE ENGINEERING

Benton, Louis Brent .... *Ft. Worth, Tex.*
Bohart, Philip Harris .... *Ft. Worth, Tex.*
Crawford, Thomas Ralph .... *Paola, Kan.*
Dowd, Raymond John .... *St. Louis, Mo.*
Duga, Joseph Benjamin .... *Bellaire, Ohio.*
Larsh, Napoleon Bonaparte .... *Nebraska City, Nebr.*
Moore, Frederick Vail .... *Crystal City, Mo.*
Morris, John Munson .... *Farmington, Mo.*
Morris, Thomas Carson .... *Farmington, Mo.*
Niece, William Latchaw .... *Tulsa, Okla.*
Nolte, William John .... *St. Louis, Mo.*
Petsch, Arthur Henry .... *Lexington, Mo.*
Schnaidt, Charles Michael .... *St. Louis, Mo.*
Starkey, Alvah Chapman .... *San Diego, Calif.*

METALLURGY

Scott, James Walter .... *Rolla, Mo.*
Smiley, Vivien Xly .... *Hannibal, Mo.*

MECHANICAL ENGINEER

Lottman, Walter Frederick .... *St. Louis, Mo.*

CHEMICAL ENGINEER

Goldman, Leon Harrison .... *St. Louis, Mo.*
Krause, Frederick Arthur .... *St. Louis, Mo.*
Nichols, Benjamin Guthrie .... *East St. Louis, Ill.*
Oyler, William Elsworth .... *Brookfield, Mo.*
Wilkinson, Paul Delassus .... *St. Louis, Mo.*

*In Absentia.

GENERAL SCIENCE

Smith, Harry Gilham................ *Vinita, Okla.*

JUNIORS

MINE ENGINEERING

Aid, Harry............................ *Gallatin, Mo.*
Beyer, Daniel Christopher.......... *Long Island City, N. Y.*
Brazill, Matthew Patrick, Jr......... *St. Louis, Mo.*
Cairns, Arthur Lee.................. *Cape Girardeau, Mo.*
Casselman, Lawrence Owen.......... *Rolla, Mo.*
Davidson, Lewis Ely................ *Savannah, Mo.*
Forgotson, James Morris............. *St. Louis, Mo.*
Gerber, Clarence Oliver.............. *Kansas City, Mo.*
Hahn, Abner Decker................ *Fruitland, Ia.*
Hippard, Wesley George............. *Belleville, Ill.*
Hollow, Edward John............... *Cuba, Mo.*
Hoppock, Harland Hobart........... *Joplin, Mo.*
Howard, Clifford Peter.............. *Wilburton, Okla.*
Howendobler, John Leslie............ *Tulsa, Okla.*
Hurd, Harold Waller................ *Paris, Mo.*
Klyman, Julius Hart................ *St. Louis, Mo.*
McMillen, Frank Morris............. *Branson, Mo.*
Mann, Marion Robert............... *Gallatin, Mo.*
Miller, John Gaines................. *Marshall, Mo.*
Norville, Glen Smith................ *Beardstown, Ill.*
Potts, Allen Dewey................. *Pittsburgh, Pa.*
Pryor, Willis George................ *Bethany, Mo.*
Rackett, Gerald Franklin............ *Chicago, Ill.*
Stroup, Robert Knox................ *Quincy, Ill.*
Uthoff, Frederick William............ *St. Louis, Mo.*
Weigel, William Walbridge........... *Fredericktown, Mo.*
Wilson, Kenneth Campbell........... *Globe, Ariz.*
Wright, Kenneth Maurice............ *Kansas City, Mo.*

METALLURGY

Hummel, Carl Bernard.............. *Kansas City, Mo.*
Kroenlein, George Alfred............ *St. Louis, Mo.*
Slover, Edwin Allsop................ *East Orange, N. J.*
Stubbs, Robert Newton, Jr........... *Kirkwood, Mo.*
Swayze, Ronald Owen............... *Pomona, Kan.*
Williams, Edgar Arthur............. *Withers Mill.*

CIVIL ENGINEERING

Barnard, Charles Russell............*St. Louis, Mo.*
Bohn, Edwin Joseph................*St. Louis, Mo.*
Novak, Joseph, Jr...................*St. Louis, Mo.*
Schuman, Edwin Kaine, LLB.........*Rolla, Mo.*
Stubbins, John Russell..............*Paris, Mo.*
Wills, Ronald Blair..................*Evansville, Indiana.*
Zieseniss, Harry Wesley.............*Rolla, Mo.*

MECHANICAL ENGINEERING

Tagggart, William Miskey, Jr.........*St. Louis, Mo.*

CHEMICAL ENGINEERING

Badollet, Marion Smith..............*Vincennes, Ind.*
Bash, David Anderson...............*Hannibal, Mo.*
Finlay, William James...............*Webster Groves, Mo.*
Gettler, Carl Andrew................*Hannibal, Mo.*
Howald, Arthur Mark................*Rolla, Mo.*
Kershner, Karl Kenneth.............*St. Louis, Mo.*
Taylor, Francis Huston..............*Rolla, Mo.*

SOPHOMORES

MINE ENGINEERING

Ahrens, Herbert Emmet.............*Corning, Mo.*
Albert, Hyman Isadore..............*St. Louis, Mo.*
Bloom, George Barnett..............*Maysville, Mo.*
Booker, Karl William................*Kansas City, Mo.*
Burford, Carroll Preston.............*Beaumont, Tex.*
Denison, William Ray...............*Rolla, Mo.*
Donai, Willard Bartholomew.........*Des Moines, Ia.*
Hollinggshead, Homer Archer........*Hannibal, Mo.*
Hughes, Harry Herbert, Jr...........*Springfield, Mo.*
Illidge, Robert Eugene...............*Corbett, Ore.*
Kerr, Homer Chalmers...............*Rolla, Mo.*
Luckfield, William Richard...........*Glenpool, Okla.*
McComb, William Randolph.........*St. James, Mo.*
McGirl, James Nathaniel............*Odessa, Mo.*
Mundt, Herbert William.............*St. Louis, Mo.*
Mutz, Herman Jacob, Jr.............*Elizabethtown. N. Mex.*
Needham, Albert Booth..............*Collinsville, Ill.*
Netzeband, William Ferdinand.......*St. Louis, Mo.*
Norville, Howard Oliver.............*Beardstown, Ill*
Patterson, Harold Reed..............*Warrensburg, Mo.*
Pray, Donald Porter.................*Wellington, Kansas.*

Quilliam, William Reed . . . . *Fowlerton, Tex.*
Schappler, Rudolph Charles . . . . *Springfield, Mo.*
Short, Leonard Rutherford . . . . *St. Louis, Mo.*
Storrs, George Walter . . . . *Hannibal. Mo.*
Swayze, Louis Mayes . . . . *Pomona, Kansas.*
Tyrrell, Morris Lee . . . . *Blackwell, Okla.*
Wilson, James Mortimer . . . . *Hannibal, Mo.*
Wilson, Joseph Martland . . . . *Rock Rapids, Iowa.*

METALLURGY

Delaloye, August Francis . . . . *Rolla, Mo.*
Huffman, Daniel Elijah . . . . *St. Louis, Mo.*
Kennedy, Ernest Carlton . . . . *Austin, Tex.*
Moore, Robert Douglass . . . . *Carthage, Mo.*
Nighswonger, Ray Dean . . . . *Cameron, Mo.*
Shih, Hsin Pu . . . . *Chiyuang, Honan, China.*
Stevens, Thomas Adrain . . . . *Caney, Kansas.*
Webb, Albert Loomis . . . . *El Paso, Tex.*

CIVIL ENGINEERING

Colbert, Jules Philip . . . . *Maryville, Mo.*
Schlesinger, Louis Max . . . . *Fredericktown, Mo.*
Smith, James Alger . . . . *Steelville, Mo.*
Wallace, Milton Wardwell . . . . *East Orange, N. J.*

MECHANICAL ENGINEERING

Deckmeyer, Frederick A. . . . . *St. Louis, Mo.*
Guy, Earl McKinley . . . . *Davenport, Iowa.*

ELECTRICAL ENGINEERING

Keeter, Vern Ivan . . . . *Maysville, Mo.*
Ross, Myral Cornelius . . . . *Newburg, Mo.*
Salmon, Julius Clarence, Jr. . . . . *Rayville, La.*

CHEMICAL ENGINEERING

Dreidel, Eugene . . . . *St. Louis, Mo.*
Fishlowitz, Victor Kopple . . . . *St. Louis, Mo.*
Kosky, John . . . . *St. Louis, Mo.*
Millar, Chalres James . . . . *Webb City, Mo.*
Nevedomsky, Samuel Leonard . . . . *St. Louis, Mo.*
Nudelman, Barney . . . . *St. Louis, Mo.*
Shanfeld, Samuel Norman . . . . *St. Louis, Mo.*

FRESHMEN

Alcorn, Irwin Myland	*Robinson, Ill.*
Ashworth, Harold Howard	*St. Louis, Mo.*
Bloom, Robert Forthun	*Richland, Mo.*
Boyle, Alfred	*St. Louis, Mo.*
Brandenburger, Oscar Louis	*Belleville, Ill.*
Brayford, Elton Burns	*Collinsville, Ill.*
Bulger, John Leo	*Gouverneur, N. Y.*
Burstein, Jacob	*St. Louis, Mo.*
Campbell, Joseph Lambert	*Rolla, Mo.*
Cardenas, Emilio de	*LaPaz, Bolivia.*
Case, Walter Earnest	*Rolla, Mo.*
Chang, Kuang Yu	*Kung-Hsien, Honan, China*
Childress, Harold Lyle	*Galena, Kansas.*
Christner, Glen Joyce	*Horton, Kansas.*
Collier, Earl Matthew	*St. James, Mo.*
Denison, Alvis Frederick	*Cushman, Ark.*
Diers, George Peter	*East Orange, J. N.*
Diers, Henry Ernest	*East Orange, N. J.*
Dougherty, John Herman	*Peoria, Ill.*
Erickson, Roy	*Madrid, Ia.*
Fisher, Otto Earnest	*St. Louis, Mo.*
Flesh, David James	*St. Louis, Mo.*
Frey, Muir Luken	*Bunker Hill, Ill.*
Gettler, Warren Roy	*Hannibal, Mo.*
Gholson, John D.	*Ranger, Tex.*
Goldman, Joseph Sidney	*St. Louis, Mo.*
Gollub, Meyer	*St. Louis, Mo.*
Grossman, Meyer Nathan	*St. Louis, Mo.*
Hagood, Lindell	*Marshall, Mo.*
Halasey, Francis Richard	*Maryville, Mo.*
Harbison, Lynn	*Kansas City, Mo.*
Hatmaker, Paul Castleton	*Gouverneur, N. Y.*
Hazeltine, Richard Gibson	*St. Louis, Mo.*
Henderson, Frank Irving	*St. Louis, Mo.*
Hosterman, John Fancis	*Kansas City, Mo.*
Hunt, Russell Wayne	*Independence, Mo.*
James, Walter Franklin	*Webb City, Mo.*
Jewell, James Edwin Jr.	*Kansas City, Mo.*
Kaley, Charles Bayard	*Gouverneur, N. Y.*
Karges, Paul Henry	*Kansas City, Mo.*
Karlson, Russell Gustavus Nathaniel	*Madrid, Iowa.*
Kendall, Harry Hughes	*Shreveport, La.*
Kenyon, Ronald John	*Rolla, Mo.*
Kjellberg, Stephen	*East Orange, N. J.*

Knight, Ralph Henry . . . . *St. Louis, Mo.*
Lay, Willard Claxton . . . . *St. Clair, Mo.*
Leonard, Homer LaKirby . . . . *Rolla, Mo.*
Loesche, Harry Charles . . . . *St. Louis, Mo.*
Long, Albert Edwin . . . . *Rolla, Mo.*
McMahan, Carl Nall . . . . *Greenfield, Mo.*
Ma, Heng Yung . . . . *An-Yang, Honan, China.*
Mahoney, Beverly Abiel . . . . *Rolla, Mo.*
Marcellus, Ralph . . . . *Vilean, Mo.*
Mesirow, Leon . . . . *St. Louis, Mo.*
Metzger, William Herman . . . . *East St. Louis, Ill.*
Miller, Corwin Everdeen . . . . *Gallatin, Mo.*
Nagel, Fremont James . . . . *Collinsville. Ill.*
Newberry, Robert Edward . . . . *Fredericktown, Mo.*
Nichols, Charles Alexander . . . . *St. Louis, Mo.*
Ohnsorg, Edward George . . . . *Alton, Ill.*
Osnoss, Nelson . . . . *St. Louis, Mo.*
Ottersbach, David Maurice . . . . *St. Louis, Mo.*
Pace, Henry Harding . . . . *Alton, Ill.*
Place, Otis Kipling . . . . *Gallatin, Mo.*
Reid, Sidney Kincaid . . . . *McAlester, Okla.*
Rembert, Ernest Wayne . . . . *Jefferson City, Mo.*
Richards, Robert Earl . . . . *Hutchinson, Kan.*
Ridley, Howard Gladstone . . . . *Greenfield, Mo.*
Rixleben, Bruno . . . . *Jonesboro, Ill.*
Schaeffer, Ammon Daniel . . . . *Springfield, Mo.*
Signer, Merton Ira . . . . *Tonica, Ill.*
Smith, Charles Landon . . . . *Rolla, Mo.*
Smith, Peyton Wemyss . . . . *Oklahoma City, Mo.*
Smith, Ralph Day . . . . *Hutchinson, Kan.*
Sotier, Alfred Leon . . . . *Alton, Ill.*
Spalding, James Arron . . . . *Hannibal, Mo.*
Starr, Frank James . . . . *St. Louis, Mo.*
Stassen, Robert Henry . . . . *Rolla, Mo.*
Sternberg, Irwin . . . . *Kansas City, Mo.*
Storrs, Stuart Esselman . . . . *Hannibal, Mo.*
Swyers, Otto Harton . . . . *St. James, Mo.*
Teter, William Earl . . . . *Bunker Hill, Ill.*
Tragitt, Edmund Rowland . . . . *Rolla, Mo.*
Wallace, John Festus . . . . *Maryville, Mo.*
Watts, Aubrey Byron . . . . *Fredericktown, Mo.*
Weimer, Walter Henry . . . . *Girard, Kan.*
Weir, Thomas Glover . . . . *Webster Groves, Mo.*
Williams, Richard John . . . . *Farmington, Mo.*
Wolverton, Thatcher Siprell . . . . *Green River, Utah.*
Wyman, Glen Sherman . . . . *Kansas City, Mo.*
Zimmerman, Russell Lawton . . . . *Bunker Hill, Ill.*

SPECIAL

Axton, Elmer Ray . . . . *Joplin, Mo.*
Cornwell, Benjamin Sedgely. . . . . *St. Louis, Mo.*
Crawford, Howard Stanley . . . . *Rivera, Calif.*
Culbertson, Catharine Alice . . . . *Rolla, Mo.*
Elias, Zella. . . . . *Rolla, Mo.*
Hynes, Julius Henry . . . . *St. Louis, Mo.*
Jones, Mabel Oma . . . . *Rolla, Mo.*
McClurken, Russell Craig . . . . *St. Louis, Mo.*
Mutz, Walter. . . . . *Elizabethtown, N. M.*
Reinoehl. Clyde Oscar . . . . *Rolla, Mo.*
St. John, Joseph Thomas . . . . *St. Louis, Mo.*
Stuerman, Harold A. . . . . *St. Louis, Mo.*
Tragitt, Sarah Louise. . . . . *Rolla, Mo.*
Turner, Basil Harold . . . . *St. Louis, Mo.*
Weldon, Elzia Bryan . . . . *Fremont, Mo.*
Yeager, Robert Lee . . . . *Joplin, Mo.*
Zeuch, Mabel Hawkins . . . . *Rolla, Mo.*

STUDENTS IN THE S. A. T. C.

Albert, Hyman Isadore
Alcorn, Irwin Myland
Ashworth, Harold Howard
Barnard, Charles Russell
Benton, Louis Brent
Bloom, Robert Forthun
Bohart, Philip Harris
Bohn, Edwin Joseph
Booker, Karl William
Boyle, Alfred
Bulger, John Leo
Burford, Carroll Preston
Burstein, Jacob
Campbell, Joseph Lambert
Case, Walker Earnest
Collier, Earl Matthew
Cornwell, Benjamin Sedgely
Delaloye, August Francis
Denison, Alvis Frederick
Diers, Geo. Peter
Diers, Henry Ernest
Dougherty, John Herman
Dreidel, Eugene
Erickson, Roy
Finlay, William James
Fischer, Otto Earnest
Forgotson, James Morris
Frey, Muir Luken
Gettler, Carl Andrew
Gettler, Warren Roy
Goldman, Joseph Sidney
Gollup, Meyer
Guy, Earl McKinley
Hagood, Lindell
Hahn, Abner Decker
Halasey, Francis Richard
Harbison, Lynn
Hatmaker, Paul Castleton
Hollingshead, Homer Archer
Hollow, Edward John
Hosterman, John Francis
Howard, Clifford Peter
Hunt, Russell Wayne
Illidge, Robert Eugene
Jewell, James Edwin
Kaley, Charles Bayard
Karlson, Russell Gustavus Nathaniel
Keeter, Vern Ivan
Kennedy, Ernest Carltson
Kerr, Homer Chalmers
Kjellberg, Stephen
Kosky, John
Kroenlein, George Alfred
Lay, Willard Claxton
Leonard, Homer LaKirby
Long, Albert Edwin
Lottman, Walter Frederick
Luckfield, William Richard
McMahan, Carl Nall
McMillen, Frank Morris
Marcellus, Ralph
Mesirow, Leon
Metzger, William Herman
Miller, John Gaines
Moore, Fred Vail
Morris, John Munson
Morris, Thomas Carson
Mundt, Herbert William
Mutz, Herman Jacob
Nagel, Fremont James
Needham, Albert Booth
Netzeband, William Ferdinand
Nevedomsky, Sam Leonard
Nichols, Benjamin Guthrie
Nichols, Charles Alexander
Niece, William Latchaw
Nighswonger, Ray Dean
Nolte, William John
Norville, Glen Smith

Norville, Howard Oliver
Novak, Joseph, Jr.
Nudelman, Barney
Ohnsorg, Edward George
Ottersbach, David Maurice
Oyler, William Ellsworth
Pace, Henry Harding
Patterson, Harold Reed
Petsch, Arthur Henry
Potts, Allen Dewey
Rackett, Gerald Franklin
Reid, Sidney Kincaid
Rembert, Ernest Wayne
Richards, Robert Earl
Ridley, Howard Gladstone
Rixleben, Bruno
Ross, Myral Cornelius
Salmon, Julius Clarence
Schaeffer, Ammon Daniel
Schnaidt, Charles Michael
Schuman, Edwin Kaine
Scott, James Walter
Shanfeld, Samuel Norman
Slover, Edwin Allsop
Smiley, Vivien Xly
Smith, Charles Landon
Smith, James Alger
Smith, Peyton Wemyss
Smith, Ralph Day
Sotier, Alfred Leon
Spalding, James Arron
Starr, Frank James
Stassen, Robert Henry
Sternberg, Irwin
Storrs, George Walter
Storrs, Stuart Esselman
Stroup, Robert Knox
Stubbins, John Russell
Swayze, Louis Mayes
Swayze, Ronald Owen
Swyers, Otto Harton
Taggart, William Miskey
Taylor, Frank Huston
Tragitt, Edmund Rowland
Tyrrell, Morris Lee
Uthoff, Fred William
Wallace, Milton Wardell
Webb, Albert Loomis
Weigel, William Walbridge
Weimer, Walter Henry
Wilkinson, Paul Delassus
Williams, Richard John
Wilson, James Mortimer
Wilson, Joseph Martland
Wolverton, Thatcher Siprell
Wyman, Glen Sherman
Zimmerman, Russell Lawton

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Volume Twelve *Number Two*

Catalogue 1919-20

SCHOOL *of* MINES *and* METALLURGY

UNIVERSITY *of* MISSOURI

BULLETIN

March : 1920

Rolla, Missouri

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Forty-Ninth Annual Catalogue

SCHOOL *of* MINES *and* METALLURGY

UNIVERSITY *of* MISSOURI

ROLLA, MISSOURI

1920

CALENDAR FOR 1920-1921

1920

JANUARY

S	M	T	W	T	F	S
–	–	–	–	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
–	–	–	–	–	–	–

FEBRUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	–	–	–	–	–	–

MARCH

S	M	T	W	T	F	S
–	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	–	–	–

APRIL

S	M	T	W	T	F	S
–	–	–	–	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
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AUGUST

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SEPTEMBER

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NOVEMBER

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DECEMBER

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1921

JANUARY

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AUGUST

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NOVEMBER

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DECEMBER

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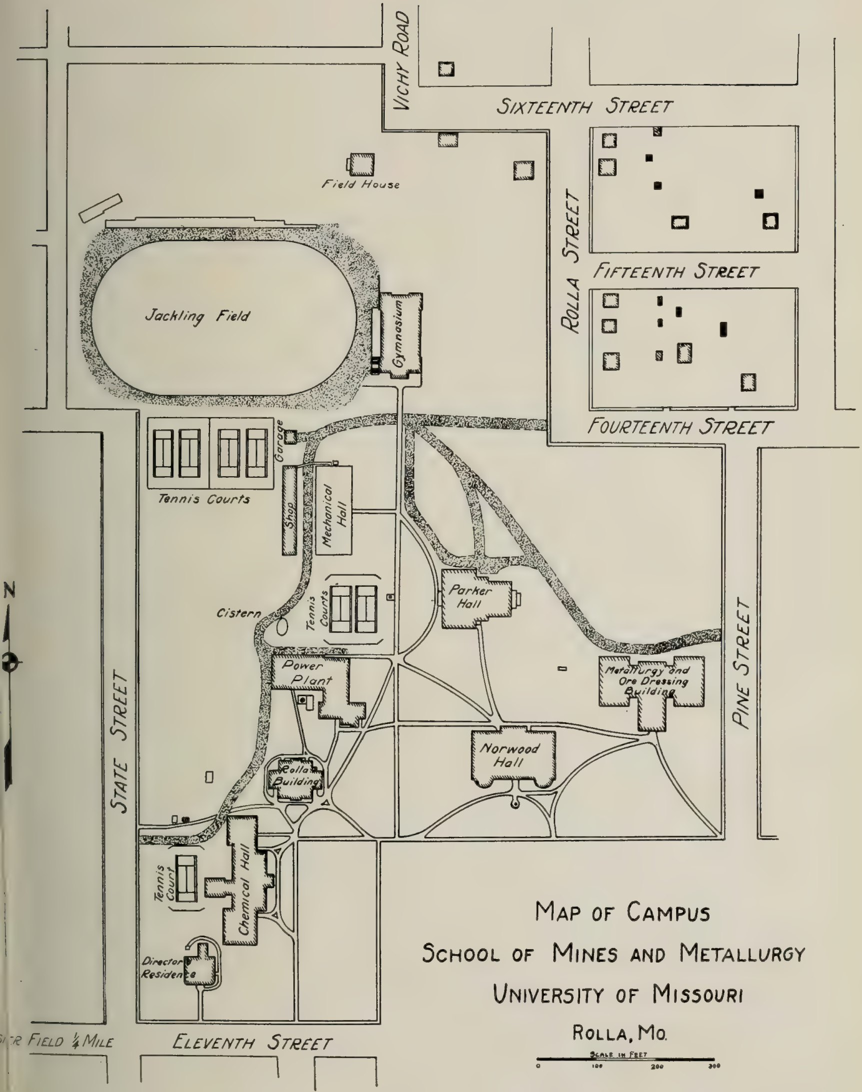


Map of Campus
School of Mines and Metallurgy
University of Missouri
Rolla, Mo.

TABLE OF CONTENTS

CALENDAR

1920

January 2 and 3, Friday and Saturday	REGISTRATION FOR WINTER TERM.
January 5, Monday	CLASS WORK BEGINS.
April 24, Saturday	COMMENCEMENT DAY.

SPRING–SUMMER TERM
1920

April 26, Monday	REGISTRATION FOR SPRING-SUMMER TERM.
June 19, Saturday	END OF FIRST HALF OR BEGINNING OF SECOND HALF OF TERM.
August 14, Saturday	SPRING-SUMMER TERM CLOSES.

FALL TERM
1920

August 30, Monday	REGISTRATION FOR FALL TERM.
November 25, Thursday	THANKSGIVING DAY, HOLIDAY.
December 22, Wednesday noon	FALL TERM ENDS.

WINTER TERM
1921

January 3, Monday	REGISTRATION FOR WINTER TERM.
February 22, Tuesday	WASHINGTON'S BIRTHDAY, HOLIDAY.
April 29, Friday	COMMENCEMENT DAY. FIFTIETH ANNIVERSARY CELEBRATION.

SPRING-SUMMER TERM
1921

April 30, Saturday	REGISTRATION FOR SPRING-SUMMER TERM.
June 25, Friday	END OF FIRST HALF OR BEGINNING OF SECOND HALF OF TERM.
August 19, Friday	SPRING-SUMMER TERM ENDS.

BOARD OF CURATORS

Term Expires January 1, 1921.

John H. Bradley, 1915 . . . . *Kennett.*
Judge Springfield Court of Appeals.
David R. Francis, 1905 . . . . *St. Louis.*
Former Governor, former Secretary of the Interior, Ambassador to Russia.
H. B. McDaniel, 1915 . . . . *Springfield.*
Banker.

Term Expires January 1, 1923.

Dr. G. E. Muns, 1917 . . . . *Montgomery City.*
Physician and Surgeon.
Curtis B. Rollins, 1909 . . . . *Columbia.*
Banker.
Milton Tootle, Jr., 1917 . . . . *St. Joseph.*
Banker.

Term Expires January 1, 1925.

Dr. S. L. Baysinger, 1907 . . . . *Rolla.*
Physician and Surgeon.
H. J. Blanton, 1919 . . . . *Paris.*
Editor and Publisher.
Judge James E. Goodrich, 1919 . . . . *Kansas City.*
Lawyer.

OFFICERS OF THE BOARD

D. R. Francis . . . . *President.*
C. B. Rollins . . . . *Vice-President.*
J. G. Babb . . . . *Secretary.*
R. B. Price . . . . *Treasurer.*

EXECUTIVE COMMITTEE

S. L. Baysinger . . . . *Rolla.*
H. B. McDaniel . . . . *Springfield.*
G. E. Muns . . . . *Montgomery City.*

OFFICERS OF THE COMMITTEE

S. L. Baysinger . . . . *Chairman.*
Edw. Kahlbaum . . . . *Secretary.*
C. M. Knapp . . . . *Treasurer.*

NORWOOD HALL.

ROLLA BUILDING.

FACULTY

ALBERT ROSS HILL,
President of the University.
A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905; Dalhousie University, 1908; Westminster College, 1909; Washington University, 1915; Lafayette College, 1915; Universities of Colorado and Michigan, 1916; University of California, 1918.

AUSTIN LEE McRAE,
Director,
B. S., University of Georgia, 1881; S. D., Harvard University, 1886.

JOSEPH WAYNE BARLEY,
Professor of English and Modern Languages.
A. B., 1897; A. M., 1905, William Jewell College; Ph. D., University of Pennsylvania, 1911.

GUY HENRY COX,
Professor of Geology and Mineralogy.
B. S., Northwestern University, 1905; M. A., 1908; Ph. D., 1911, University of Wisconsin; E. M., School of Mines, 1914.

GEORGE REINALD DEAN,
Professor of Mathematics.
C. E., 1890; B. S. in Mathematics and Physics, School of Mines, 1891.

HAROLD SHIELDS DICKERSON,
Professor of Mechanical Engineering.
B. S., University of Michigan, 1905; B. S.; M. E., 1911, Purdue University.

CARROLL RALPH FORBES,
Professor of Mining.
B. S., 1902; E. M., 1903, Michigan College of Mines.

ELMO GOLIGHTLY HARRIS,
Professor of Civil Engineering.
C. E., University of Virginia, 1882.

WILLIAM DeGARMO TURNER,
Professor of Chemistry.
B. S., 1909, Ph. D., 1917, University of Chicago.

HAROLD LESLIE WHEELER,
Librarian.
A. B., Brown University, 1910; B. L. S., New York State Library School, 1913.

HERBERT JOSEPH WILD,
Professor of Military Science and Tactics.
C. E., Pennsylvania Military College, 1896; Major, Engineer Corps, U. S. Army.

LEON ELMER WOODMAN,
Professor of Physics.
A. B., 1899, A. M., 1902, Dartmouth College; Ph. D., 1910, Columbia University.

HENRY HORTON ARMSBY,
Associate Professor of Civil Engineering.
B. S., 1911, C. E., 1916, Pennsylvania State College.

CHARLES YANCEY CLAYTON,
Associate Professor of Metallurgy and Ore Dressing.
B. S., 1913, Met. E., 1916, School of Mines.

CHARLES LAURENCE DAKE,
Associate Professor of Geology and Mineralogy.
A. B., 1911; A. M., 1912, University of Wisconsin.

FRANK EDWARD DENNIE,
Associate Professor of Athletics and Physical Director.
B. S. in Civil Engineering, Brown University, 1909.

LEON ELLIS GARRETT,
Associate Professor of Mathematics.
B. S. in General Science, School of Mines, 1901.

EDGAR SCOTT McCANDLISS,
Associate Professor of Civil Engineering.
B. S. in Civil Engineering, Purdue University, 1909; C. E., School of Mines, 1917.

FREDERICK WILLIAM SHAW,
Student Health Adviser.
M. D., 1906, University of Kansas.

ROLLAND SCHANEL WALLIS,
Associate Professor of Drawing.
B. S. in E. E., 1907; B. S. in C. E., 1909; C. E., 1915, Iowa State College.

JOSEPH HENRY BOWEN,
Assistant Professor of Shop Work and Drawing.
Graduate, Miller School, Virginia.

FRANCIS POTTER DANIELS,
Assistant Professor of Modern Languages.
A. B., University of Michigan, 1895; A. M., University of Missouri, 1897; Ph. D., University of Missouri, 1905.

HOWARD LEROY DUNLAP,
Assistant Professor of Chemistry.
B. S., Ohio University, 1912; M. A., Ohio State University, 1914.

FLOYD HILL FRAME,
Assistant Professor of Physics and Electricity.
A. B., Clark College, 1912.

EUGENE LEE JOHNSON,
Assistant Professor of English.
Ph. B., Emory College, 1899; LL. B., Mercer University, 1902; Ph. B., Chicago University, 1910.

GARRETT A. MUILENBURG,
Assistant Professor of Geology and Mineralogy.
A. B., 1912, M. S., 1913, University of Iowa.

WOLDEMAR MARKOVITCH STERNBERG,
Assistant Professor of Chemistry.
Chem. E., Institute of Technology, Petrograd, Russia, 1908; Ph. D., University of Minnesota, 1918.

MARTIN HARMON THORNBERRY,
Research Assistant, Experiment Station; Acting Assistant Professor of Ore Dressing.
B. S., 1912, B. S., 1917, School of Mines.

CLARENCE EDWARD BARDSLEY,
Instructor in Mathematics.

VAN BUREN HINSCH,
Instructor in Mathematics.
B. S., 1909, E. M., 1917, School of Mines.

ALLEN DEWEY POTTS,
Instructor in Metallurgy.

ARTHUR SCOTT,
Instructor in Military Science and Tactics.
Master Engineer U. S. Army.

JOSEPH HENRY UNDERWOOD,
Instructor in Forge Shop.

EVAN EARL ASHLOCK,
Assistant in Machine Drawing.

LORAIN HARRY CUNNINGHAM,
Assistant in Mathematics.

LEWIS ELY DAVIDSON,
Assistant in Woodshop.

GERALD FRANKLIN RACKETT,
Assistant in Mathematics.

EDWIN ALLSOP SLOVER,
Assistant in Industrial Mathematics.

THOMAS FRANCIS WALSH,
Graduate Assistant in English.
B. S., School of Mines, 1917.

HANLEY WEISER,
Graduate Assistant in Chemistry.
B. S., School of Mines, 1918.

RONALD BLAIR WILLS,
Assistant in Industrial Mathematics.

OTHER OFFICERS

ROBERT RICHMOND DICKERSON,
Superintendent of Buildings and Grounds.

EDW. KAHLBAUM,
Registrar.

MARGUERITE NORVILLE,
Assistant Librarian.

ZELLA ELIAS,
Stenographer.

ELIZABETH MONTGOMERY,
Stenographer.

STUDENT ASSISTANTS

Chemistry.

Marion Smith Badollet.
†Victor Kopple Fischlowitz.
Arthur Mark Howald.
Barney Nudelman.
*Samuel Norman Shanfeld.
*Mark Loren Terry.
†Ernest Sterling Wheeler.

Civil Engineering.

Philip Jules Colbert.
*Leon Burr Schumacher.
John Russell Stubbins.
†Kenneth Maurice Wright.

English.

Samuel Horace Lloyd, Jr.
Thomas Patrick Walsh.

Geology and Mineralogy.

William Ferdinand Netzeband.
Gerald Franklin Rackett.

Mechanical Engineering.

Theodore Clayton Sherwood, Jr.

Metallurgy and Ore Dressing.

Thomas Witt Leach.

Physics.

Milburn Lee Dorris.

Gymnasium.

Robert Bruce.
Earle Nelson Murphy.
Roscoe Nelvin Place.

Mining:

Frederick William Uthoff.

Drawing.

Alfred Boyle.
Harry C. Loesche.
*William John Nolte.
†Harry Wesley Zieseniss.

*Fall Term. †Winter Term.

SPECIAL LECTURES

U. S. Bureau of Mines Moving Picture Films.
"Mining of Coal."
September 19, 1919.

Frederick G. Moses, E. M., Hydrometallurgist U. S. Bureau of Mines, Salt Lake City, Utah.
"Treatment of Refractory Ores by the Wet and the Dry Chlorination Methods."
October 14, 1919.

Earl S. Bardwell, S. B., Superintendent of Ferrous-Alloy Plant, Anaconda Copper Company, Great Falls, Mont.
"The Electrolytic Zinc Plant at Great Falls, Montana."
October 13, 1919.
"Electrolytic Copper Refining."
October 14, 1919.

H. T. Abrams, Mgr. Air Lift Pump Department, Ingersoll-Rand Company.
"The Use of the Air Lift Pump in Tailings Disposal at Hurley, New Mexico."
October 15, 1919.

Kurt C. Barth, The Barrett Co. of New York.
"Wood Preservation and Preservation of Mine Timbers."
December 5, 1919.

Dr. J. J. Rutledge, U. S. Bureau of Mines, McAlester, Okla.
"First Aid and Mine Rescue."
December 10, 1919.

Louis A. Delano, E. M., Mill Supt., St. Joseph Lead Co., Bonne Terre, Mo.
"Recent Changes in Milling Practice at Bonne Terre, Mo."
December 16, 1919.

Harry H. Nowlan, B. S., Petroleum Geologist, Tulsa, Okla.
"Psychology in Business."
January 23, 1920.

George Ware Stephens, Ph. D., Washington University, St. Louis, Mo.
"Engineering and Some Economic Aspects of Industry."
January 30, 1920.

Mervin J. Kelly, Ph. D., Western Electric Co., New York City.
"Wireless Communication."
February 5, 1920.

H. G. S. Anderson, E. M., Assistant General Manager Chino Copper Co., Hurley, N. Mex.
"Sponge Iron as a Precipitant for Copper."
February 10, 1920.
"Mining Costs."
February 11, 1920.

Lewis L. Scott, Standard Engineering Co., St. Louis.
"High Pressure Steam."
February 20, 1920.

William DeGarmo Turner, Ph. D., Professor of Chemistry, School of Mines.
"Liquid Air."
February 29, 1920.

Grant Shepherd, New York City, "Organization and operation of the Brader Copper Co."
March 3, 1920.

Frank R. Loveridge, B. S., Asst. Supt. Continental Cement Co.,
"Manufacture of Cement."
March 12, 1920.
Cement Plant Construction.
March 13, 1920.

Clark R. Mandigo, M. C. E., Chief Engineer, Western Paving Brick Manufacturers Association, Kansas City, Mo.
March 26, 1920.

FACULTY COMMITTEES, 1919-20.

Admission and Advanced Standing.

DEAN, BARLEY, TURNER.

Athletics, Drill and Physical Education.

COX, DENNIE, FORBES, SHAW, WILD.

Curriculum and Undergraduate Degrees.

DEAN, DAKE, DICKERSON, GARRETT, TURNER.

Discipline.

FORBES, BARLEY, COX, JOHNSON, WALLIS.

Mass Meeting.

ARMSBY, DENNIE, THORNBERRY, WALLIS, WOODMAN.

Petitions.

BARLEY, GARRETT, MCCANDLISS.

Publications.

BARLEY, DAKE, WHEELER.

Theses and Graduate Degrees.

HARRIS, CLAYTON, DANIELS, FORBES, WOODMAN.

Secretary of the Faculty.

MCCANDLISS.

HISTORICAL

The University of Missouri was established by an act of the General Assembly of the State of Missouri, approved February 11, 1839, two days after the act establishing the public school system of the state was approved.

The University was located at Columbia, Boone county, June 24, 1839. The cornerstone of the main building was laid July 4, 1840. The spring following, April 14, 1841, instruction in academic courses was begun. Women were first admitted to the University in 1869. The first class, consisting of two members, was graduated in 1843.

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College at Columbia and a School of Mines and Metallurgy in Southeast Missouri.

The School of Mines and Metallurgy was located at Rolla, Phelps county. Here, in November, 1871, the school was formally opened. The first class of three members was graduated in 1874. The present senior class has a membership of fifty-nine.

Sec. 11097. *Corporate name and powers—eminent domain.*—The university is hereby incorporated and created a body politic, and shall be known by the name of "The curators of the university of Missouri," and by that name shall have perpetual succession, power to sue and be sued, complain and defend in all courts; to make and use a common seal, and to alter the same at pleasure; to take, purchase and to sell, convey and otherwise dispose of lands and chattels; to condemn and appropriate real estate or other property, or any interest therein, for any public purpose within the scope of its organization, in the same manner and with like effect as is provided in chapter 22, article II of the Revised Statutes of 1909: *Provided*, that if the curators so elect, no assessment of damages or compensation under this article shall be payable, and no execution shall issue before the expiration of sixty days after the adjournment of the next regular session of the legislature held after such assessment is made, but the same shall bear interest at the rate of six per cent. per annum from its date until paid; *and provided further*, that the curators may, at any time, elect to abandon the proposed appropriation of property by an instrument of writing to that effect, to be filed with the clerk of the court and entered on the minutes of the court, and as to so much as is thus abandoned, the assessment of damages or compensation shall be void: *Provided*, that the curators shall not have power to sell or convey any land contained within the university campus. (Laws 1909, p. 884.)

Sec. 11098. *Curators, number of and how appointed.*—The board of curators of the university of the state of Missouri shall hereafter consist of nine members, who shall be appointed by the governor, by and with the advice and consent of the senate: *Provided*, that not more than one person shall be appointed upon said board from the same congressional district, and no

person shall be appointed a curator who shall not be a citizen of the United States, and who shall not have been a resident of the state of Missouri two years next prior to his appointment. Not more than five curators shall belong to any one political party. (Laws 1909, p. 884.)

Sec. 11099. *The term of service—classification—compensation.*—The term of service of the curators shall be six years, the terms of three expiring every two years, the first expiration occurring on the first day of January, 1911, and succeeding expirations of three members every two years thereafter. Said curators, while attending the meetings of the board, shall receive their actual expenses, which shall be paid out of the ordinary revenues of the university. (Laws 1909, p. 884.)

Sec. 11100. *Executive board—executive committee of school of mines—duties—compensation.*—The board of curators shall appoint annually three of their number to act as an executive board, who shall meet each month for the purpose of auditing claims and attending to such other business as may be intrusted to them by the board of curators not inconsistent with this article. The members of the executive board shall receive five dollars per day for each day they shall attend the monthly meetings, together with their actual expenses, to be paid as the expenses of the curators are paid. Said executive board shall be subject to change or removal at pleasure of the board of curators. The board of curators shall also appoint annually three of their number to act as an executive committee of the school of mines and metallurgy, with like powers and compensation as those of the executive board at Columbia. Said executive committee shall also be subject to change or removal at pleasure of the board of curators. (Laws 1909, p. 884.)

Sec. 11133. *College of agriculture and school of mines established.*—There is hereby established a college of agriculture at Columbia and a school of mines and metallurgy at Rolla, provided for by the grant of the congress of the United States, as distinct departments of the university of the State of Missouri. (Laws 1909, p 884.)

Object of These Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (Laws 1915, Sec. 11134.)

Right to Confer Degrees.—The College of Agriculture and the School of Mines and Metallurgy shall have power to confer degrees suitable to their designs and courses of study; and the School of Mines and Metallurgy shall provide courses for, and shall confer the bachelor of science and professional degrees in mining engineering, in metallurgy, in mechanical engineering, in electrical engineering, in chemical engineering, in civil engineering and the degrees of bachelor and master of science in general science. (Laws 1915, Sec. 11141.)

"*Academic Course of Study, etc.*—That the obligation of the State to the General Government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the University of the State of Missouri shall prescribe and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of a bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof." (Revised Statutes, 1909, Sec. 11135.)

ENDOWMENT

1. Land Grant.—The proceeds from the sale of 275,000 acres of land granted to Missouri by Act of Congress of July 2, 1862. Most of this land has been sold and the sum invested in State Certificates of Indebtedness, yielding 5 per cent interest, and in municipal and drainage district bonds. The School of Mines receives one-fourth of this income, amounting to $4,588.52 annually. (See R. S. 1909, Sec. 11161, and Session Acts, 1911, p. 415.)

2. Morrill Bill.—An annual appropriation of $50,000 by Act of Congress, approved August 30, 1890. One-sixteenth of this amount is by law appropriated to Lincoln Institute and one-fourth of the remainder, amounting to $11,718.75, to the School of Mines (See R. S. 1909, Sec. 11171.)

3. Seminary Fund.—The proceeds from the sale of land donated to the School of Mines is invested in a State Certificate of Indebtedness of $2,000. The interest on this certificate amounts to $100 annually. (See R. S. 1909, Sec. 11161.)

4. Direct Tax Endowment.—In 1891 the Government returned to the various states the sums collected from its citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23. The Thirty-sixth General Assembly established this as a permanent endowment to the University and School of Mines. This endowment is invested in a State Certificate of Indebtedness bearing 5 per cent interest. The School of Mines receives one-fifth of this sum, amounting to $6,469.58. (See R. S. 1909, Sec. 11161.)

LOCATION

The School of Mines is located at Rolla, the county seat of Phelps county, on the St. Louis and San Francisco Railroad, approximately halfway between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above the sea level, and has an agreeable and notably healthful climate. Its position on the great transcontinental railway system makes it readily accessible.

The school is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of mining, geology, mining methods, ore dressing, and mining machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores, have given the school advantages for the application of the theories of geology, mining, and ore dressing to practice.

The smelting industry of the State is very important, and every courtesy is extended to the professors and students of the school during their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay-working and cement plants in St. Louis and vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also various chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are thirty-two acres in extent. The campus contains beautiful lawns, groves of native oak, and maple shade trees.

The Jackling Field has a good baseball diamond, a football gridiron, tennis courts, and a 440-yard running track.

The gymnasium is conveniently situated at the east end of the athletic field and is equipped with lockers, shower baths, dressing rooms, swimming pool and the usual gymnastic apparatus.

The golf links, consisting of approximately eighty acres, are situated on Tenth street just west of the city limits and within four blocks of the campus.

SCHOOL YEAR

Instruction now runs forty-eight weeks during the year, three terms of sixteen weeks each. The curriculum is based on the fall and winter terms. For the present some fall and winter term subjects will be given in the summer term, fall term subjects being given during the first eight weeks and winter term subjects during the second eight weeks. The student will take half as many subjects but will take them twice as intensively. For example, English is given three times a week during the fall and winter terms; it will be given six times a week during the summer term.

PENALTY FOR ABSENCES

The Faculty has adopted the following rules relative to absences:

Any student who absents himself from any class during either of the two days immediately preceding, or the two days succeeding any regular holiday or vacation term of the School of Mines, shall be reported to the Director and unless he can offer a satisfactory explanation the Director shall instruct the Registrar to record against him on his record card negative credit hours to the amount of not less than two or more than eighteen clock hours for one offense. These hours shall be subtracted from the total number of hours counting toward graduation.

A student shall receive three negative hours for each total of seventeen absences during the term, or for a total of twenty-six absences during the fall and winter terms. For the purpose of this rule a student who registers in the School of Mines after the regular registration period shall be recorded absent for all class periods prior to registration.

STUDENT HEALTH

The School of Mines Health Service has been established to safeguard the health of the students. This is accomplished by education, through lectures, sanitation, supervising the students' environment, and personal examination and advice.

Thorough physical examinations will be made of all students entering the school. The result of such examination is recorded and is used to determine the kind of physical exercise which will be assigned to the student.

Fifteen lectures on hygiene are given during the first term to all Freshmen and first-year students.

BUILDINGS

Rolla Building.

This building was originally built by the City of Rolla at a cost of $30,000 as a High School building, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, including a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey.

Chemical Hall.

The main portion of this building was erected in 1885 at a cost of $15,000. Two wings and a second story were added in 1902 at a cost of $13,000. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five feet by sixty feet and one story high. A stock room twenty-eight feet wide by fourty-four feet long, two stories high, was erected in 1915 at a cost of $3,000, and is accessible to the qualitative and quantitative laboratories. This entire building, including a large basement, is used for chemistry.

Power Plant.

This building, erected in 1895 at a cost of $15,000, is a tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, an instrument room, and laboratories—the other comprising an engine room, a boiler room, and a mechanical engineering laboratory. The boiler room was extended in 1909 at a cost of $2,000.

Mechanical Hall.

This two-story brick building, erected in 1901 at a cost of $12,000, is one hundred fifty feet by sixty feet and was specially designed for mechanical work. The second floor includes a demonstration lecture room and a shop for bench work in wood. The first floor contains a lathe room for wood turning, a forge room, a metal-working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers, and an office for the instructor.

Norwood Hall.

The cornerstone of this building was laid November 23, 1902, and the building completed in 1903 at a total cost of $87,500. It contains adequate quarters for lecture and recitation rooms for physics, geology, mineralogy, mining engineering, civil engineering, English, mathematics, also drawing rooms and laboratories for physics, geology, mineralogy, civil engineering and mechanical engineering.

Ore Dressing Building.

This is a three-story gray press-brick building with a basement and two large one-story wings. Two stories and the west wing have been in u e since January, 1908, and the east wing was erected in 1909. The building provides quarters for metallurgy and ore dressing. The building was completed in 1911 at a total cost of $52,000, and contains over twenty-five thousand square feet of floor space.

Parker Hall.

This is a fire-proof, two-story gray press-brick building, with a well-lighted basement. The main portion of the building is one hundred two by fifty-five feet and the wing is fifty-eight by sixty feet. The library occupies the second story of the building; the administrative offices, faculty room, and board room are located on the first floor; and the assembly room is in the two-story wing. In the basement are the testing machines and the cement laboratories. This building was erected in 1912 at a cost of $73,000.

The Gymnasium.

This building, which was completed in 1915, was made possible by the appropriation of seventy thousand dollars by the Forty-seventh General Assembly. The Gymnasium is located at the north end of the campus, in a portion of Main street which was vacated by the City of Rolla for the purpose. The front is to the south, and the west side opens onto Jackling Field.

The building occupies a space seventy-two feet wide and one hundred twenty-seven feet long, and is finished in dark red, rough brick with gray terra-cotta trimmings. The interior is of fire-proof construction, with concrete and composition floors, except in the gymnasium proper, which is floored with maple. Tile partitions are used throughout the building, and the roof is concrete, supported by steel trusses and covered with asbestos roofing.

On the ground floor, entered by the main entrance on the south of the building, are the cloakrooms, locker rooms, training quarters and visiting teams' room, shower baths and swimming pool. The swimming pool is twenty by sixty feet, finished in white enamel and equipped with all modern appliances. The water supplied to the pool is circulated with a small motor-driven pump, and a constant temperature is maintained by passing the water through a special steam boiler.

The mezzanine floor is on a level with Jackling Athletic Field, and opens upon a terrace which parallels the running track. On this floor are committee rooms, general toilet rooms, the auxiliary gymnasium and balcony overhanging the swimming pool. On the second floor is the gymnasium room proper. This room is seventy feet wide by ninety feet long and is well equipped. On this floor also is the examination room, office and reception room.

The gallery of the gymnasium is a running track, with twenty-six laps to the mile. At the south end of the building on the third floor is a large lounging and rest room.

Carpenter Shop.

The general repair work of the school and construction of laboratory equipment is carried on in a frame building, one hundred fifty feet by twenty-two feet. This building is located west of Mechanical Hall, and includes a storeroom for lumber.

LIBRARY

HAROLD L. WHEELER, Librarian; MRS. NORVILLE, MR. FORMAN, MR. WHITWORTH, MR. REID, MR. NORVILLE.

The library occupies the second floor of Parker Hall. Its quarters consist of a large, well-lighted reading room, a stack room equipped with a double-deck Snead stack, capacity 45,000 volumes, and a suite of offices and workrooms for the library staff. All equipment is new and up-to-date, meeting in every way the needs of the library and its clientele.

The collection of books numbers about 23,000 carefully selected volumes, together with a large collection of pamphlets, bulletins and reports of mining companies. The library has one of the most complete files in the middle West of American and foreign technical journals and the proceedings of scientific and engineering societies. These resources are constantly increased with reference to the different courses of study, while at the same time there is kept in view the development of a well-rounded general library. The bulk of the collection consists of works in the sciences, chiefly geology, physics, chemistry, and the useful arts, the main part of this division being engineering and mining treatises. Besides these collections, the library has the representative works of contemporary American and English literature, a good section of fiction, some biography, and the latest books of description and travel, the latter division being kept especially strong, so that the students may be informed concerning the manners and customs of the people and the characteristics of the countries into which they are likely to go to follow their vocation.

The library is a subscriber to the standard technical periodicals and the publications and transactions of societies and congresses. The leading general magazines are taken for recreational reading. The contents of the back files of this material is made available through the general periodical indexes, the engineering and mining indexes, and other bibliographic aids.

The Dewey decimal system of classification is used and the resources of the collection are made available through a full dictionary catalogue of authors, titles, and subjects.

Interlibrary loan arrangements exist between this library and the Library of Congress, the St. Louis Public Library, the John Crerar Library of Chicago, the University Library at Columbia

and a number of other large libraries. By this arrangement books not in the collection at the School of Mines may be borrowed for the use of the students for a limited time.

The reading room is open daily from 8 to 12; 1 to 6, and 7 to 10; Sunday, 2 to 5. Books and periodicals may be borrowed by all officers and students of the school, and by others having permission.

ADMISSION

Under the statutes, persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good, liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman class at entrance was about eighteen years. Specific requirements have been fixed by consideration of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries.

Students are admitted in the following ways:

By Certificate:

Applicants who are graduates from fully accredited high schools will be admitted without examination, provided they present a certificate signed by the superintendent or principal showing that the applicant has to his credit fifteen units. Of these units three in English, one and one-half in Algebra, one in Plane Geometry are required.

Graduates of fully accredited high schools who lack credit in the required units must pass an examination to make up such deficiency.

Graduates of partially accredited high schools must pass examination in all of the units in which they are deficient.

By Examination:

Applicants who are not graduates of approved high schools are required to pass examinations in fifteen units as outlined below, a unit being equivalent to a year's work in one subject as given in approved high schools. Conditions may be allowed in two of the fifteen units, but these must be removed within one year from the date of entrance.

Applicants from accredited high schools who are not graduates will not be permitted to enter if they receive conditions in any subject or subjects unless a year or more has elapsed since they attended the high school.

By Advanced Standing:

Applicants may be admitted to advanced standing either upon examination in the subjects of the previous year or years or upon certificate from another institution of work accomplished which, in the estimation of the faculty, is equivalent to that completed here by the class into which entrance is sought. They must also before becoming candidates for degrees present evidence of the satisfactory completion of all entrance requirements into the Freshman class. Every applicant must also present a letter of honorable dismissal from the school last attended. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the students within one semester after entrance.

As Special Students:

Special students may be admitted without passing the entrance examination under the following provisions:

1. They must be at least twenty-one years of age.
2. They must show good reasons for not taking a regular course.
3. They must pass such examinations or other tests as shall demonstrate their fitness to pursue profitably all the subjects selected by them.
4. They shall not be candidates for a degree.
5. Special students are expected to do particularly good work in the subjects which they choose. If at any period of the session their work becomes unsatifactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature, they will be required to take at the same time as much classroom work as the faculty may designate for each particular class.

Definition of Entrance Units.

ENGLISH (4 units).

The four units that may be offered in English include grammar, composition and rhetoric, and literature.

The candidate will be required to show a reasonable proficiency in the principles of English grammar, including sentence analysis. He will be required to show the ability to express himself coherently and correctly, with a fair mastery of the forms of writing, spelling and punctuation, sentence and paragraph structure. He will be examined on the literature selected by the College Entrance Requirements Board, description of which will be furnished on request; and if four units are desired, he will be required to show also knowledge of the history of English literature.

MATHEMATICS (4 units).

The four units which may be offered in mathematics are as follows:

Algebra. (1½ units.) Elementary Algebra, including the elementary operations, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and coefficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomial theorem for positive integral exponent, ratio and proportion, and logarithms.

While the study of these particular subjects is recommended, it is not expected that the student shall be able to pass an examination on each and every one of them.

Plane Geometry. (1 unit.) The work in plane geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of algebra to geometry, and of geometry to algebra and arithmetic.

Solid Geometry. (1½ unit.) The same recommendations apply here as in plane geometry.

Trigonometry. (1 unit.) It is to be understood at the outset that this work will not be accepted for advanced standing. This branch of mathematics is of such great importance to the practical engineer that the whole subject must be reviewed and the student led to a point of view which it is impossible to attain in a high school course.

HISTORY.

Four units may be offered in history: one each in Ancient History, Medieval and Modern History, English History, and American History.

CIVIL GOVERNMENT.

One-half unit may be offered in Civil Government. This is the equivalent of one-half year's work in the fourth year of a high school, and the applicant should have a knowledge of the chief organs of local, state, and national government and a knowledge of the historical development of the government.

PHYSIOGRAPHY.

A student may offer one unit in physiography. A description of this unit will be sent on request.

PHYSICS.

The two units that may be offered in physics are as follows:

1. A year's work, five periods per week, of which at least two must be double periods in individual laboratory work. At least thirty-five exercises, selected from a list of sixty or more, equivalent to those recommended by the National Educational Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory notebooks must be presented by those who are required to take the entrance examination.

DRAWING.

Two units may be offered.

MANUAL TRAINING.

Two units in manual training may be offered. One unit should be in Bench Work and one in Mechanical Drawing. The time required in each of these subjects is five double periods for one year or five single periods for two years. Where conditions permit it is generally advisable to give these subjects as parallel courses.

LATIN.

The four units that may be offered in Latin are as follows:

1. Collar and Daniel's First Latin Book, or the equivalent.

2. Three books of Caesar's Gallic War with composition base thereon in Moulton and Collar's Preparatory Latin Composition or in Daniel's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romal, Nepos, or Eutropius may be offered.

3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.

4. Ovid's Metamorphoses (2,000 lines) and four books of Virgil's Aeneid, with prosody.

GREEK.

Three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten Orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman 's Parallel Exercises based on Lysias.

GERMAN, FRENCH, SPANISH.

Three units may be offered in German, French, or Spanish. A description of the units will be sent on request. These units will not be accepted for advanced standing.

CHEMISTRY.

The two units that may be offered in chemistry are as follows:

1. A year's work in chemistry, five periods per week, of which at least two must comprise laboratory work.

2. A second year's work in the subject, five periods per week, of which at least two must be laboratory work.

Notebooks showing work done must be presented by those who are required to take the entrance examinations.

These courses will be accepted for admission, but not for advanced standing.

BOOKKEEPING.

One unit may be offered.

COMMERCIAL GEOGRAPHY.

One-half unit may be offered.

Following is a list of schools whose courses have been approved by the University and whose diplomas will admit to the Freshman class without examination.

ACCREDITED SCHOOLS IN MISSOURI*

FULLY ACCREDITED SCHOOLS

Academy of the Sacred Heart (Maryland and Taylor avenues, St. Louis)
Academy of the Sacred Heart (Merrimac and Nebraska avenues, St. Louis)
Academy of the Visitation (St. Louis)
Adrian High School
Albany High School
Anderson High School
Appleton City High School
Armstrong High School
Ash Grove High School
Aurora High School
Auxvasse Consolidated High School No. 1
Ava High School
Benton High School
Bethany High School
Bevier High School
Billings High School
Bismarck High School
Bloomfield High School
Blue Springs High School
Bolivar High School
Bonne Terre High School
Boonville High School
Bosworth High School
Bowling Green High School
Braymer High School
Breckenridge High School
Brookfield High School
Brunswick High School
Bucklin High School
Buckner High School
Buffalo High School
Bunceton High School
Burlington Junction High School
Butler High School
Cabool High School
Cainesville High School
Callao High School
California High School
Cameron High School
Campbell High School
Canton High School
Cape Girardeau High School
Carrollton High School
Carterville High School
Carthage High School
Caruthersville High School
Cassville High School
Center High School
Centralia High School
Charleston High School
Chillicothe High School
Chula High School
Clarence High School
Clayton High School
Clifton High School
Clinton High School
Coffey High School
Cole Camp High School
Columbia High School
Corder High School
Country Day School (Kansas City)
Craig High School

*Certificates will be accepted from high schools in other states which are affiliated with their respective State Universities provided these are of similar rank with the University of Missouri.

Crane High School
Dearborn High School
Deepwater High School
DeKalb High School
De LaSalle Academy (Kansas City)
Desloge High School
DeSoto High School
Dexter High School
Doniphan High School
Downing High School
Drexel High School
East Prairie High School
Edgerton High School
Edina High School
Eldon High School
Eldorado Springs High School
Elsberry High School
Elvins High School
Eolia High School
Esther High School
Eureka High School
Everton High School
Excelsior Springs High School
Fairfax High School
Farmington High School
Fayette High School
Ferguson High School
Festus High School
Flat River High School
Fornfelt High School
Forsythe High School
Frankford High School
Fredericktown High School
Fulton High School
Gallatin High School
Garden City High School
Galt High School
Gilman City High School
Glasgow High School
Golden City High School
Gorin High School
Gower (C. D.) High School
Graham Consolidated High School
Grant City High School
Green City High School
Greenfield High School
Greenville High School
Hale High School
Hamilton High School
Hannibal High School
Hardin High School
Harrisonville High School
Hayti High School
Hickman Mills High School
Higbee High School
Higginsville High School
Holden High School
Hopkins High School
Hosmer High School (St. Louis)
Houston High School
Humansville High School
Hume Consolidated High School No. 4
Huntsville High School
Iberia Academy (Iberia)
Independence High School
Ironton High School
Jackson High School
Jamesport High School
Jameson (C. D.) High School
Jasper High School
Jefferson City High School
Joplin High School
Kahoka High School
Kansas City Central High School
Kansas City Manual Training High School
Kansas City Northeast High School
Kansas City Westport High School
Kemper Military School (Boonville)
Kennett High School
Kendrick Catholic Boys' High School (St. Louis)
Keytesville High School
Kidder Institute (Kidder)
King City High School
Kirksville High School
Kirkwood High School

Knobnoster High School
Knox City High School
LaBelle High School
Laclede High School
LaGrange High School
Lamar High School
Lamonte High School
Lancaster High School
LaPlata High School
Lathrop High School
Lawson High School
Leadwood High School
Lebanon High School
Lees Summit High School
Lenox Hall (St. Louis)
Lewistown (C. D.) High School
Lexington High School
Liberal High School
Liberty High School
Linneus High School
Lockwood High School
Loretto Academy (Kansas City)
Louisiana High School
Macon High School
Madison High School
Maitland High School
Malden High School
Maplewood High School
Marceline High School
Marionville High School
Marshall High School
Marshfield High School
Mary Institute (St. Louis)
Maryville High School
Maysville High School
Meadville High School
Memphis High School
Mexico High School
Milan High School
Mindenmines Consolidated High School No. 2
Missouri Military Academy (Mexico)
Moberly High School
Monett High School
Monroe City High School
Montgomery City High School
Morehouse High School
Morley High School
Mound City High School
Mountain Grove High School
Mt. Vernon High School
Neosho High School
Nevada High School
New Franklin High School
New Hampton High School
New Haven High School
New London High School
New Madrid High School
Norborne High School
Novelty High School
Oak Grove High School
Odessa High School
Oregon High School
Orrick High School
Osceola High School
Otterville High School
Overland (C. D.) High School
Ozark High School
Palmyra High School
Paris High School
Pattonsburg High School
Peirce City High School
Perry High School
Perryville High School
Piedmont High School
Platte City High School
Plattsburg High School
Pleasant Hill High School
Polo High School
Poplar Bluff High School
Portageville High School
Potosi High School
Princeton High School
Queen City High School
Raymore Consolidated High School No. 4
Republic High School
Rich Hill High School
Richland High School
Richmond High School
Ridgeway High School

Rockport High School
Rocky Comfort High School
Rolla High School
Rosati-Kain High School (St. Louis)
St. de Chantal Academy (Springfield)
St. Charles High School
Ste. Genevieve High School
St. James High School
St. Joseph Benton High School
St. Joseph Central High School
St. Joseph's Academy (St. Louis)
St. Louis Central High School
St. Louis Grover Cleveland High School
St. Louis McKinley High School
St. Louis Soldan High School
St. Louis Yeatman High School
St. Teresa's Academy (Kansas City)
St. Vincent's Academy (Kansas City)
Salem High School
Salisbury High School
Sarcoxie High School
Savannah High School
Sedalia High School
Seneca High School
Seymour High School
Shelbina High School
Shelbyville High School
Sheridan High School
Sikeston High School
Skidmore High School
Slater High School
Smithton High School
Smithville High School
Springfield High School
Stanberry High School
Steelville High School
Stewartsville High School
Stockton High School
Sturgeon High School
Sullivan High School
Sweet Springs High School
Tarkio High School
Thayer High School
Tina High School
Tipton High School
Trenton High School
Triplet High School
Troy High School
Union High School
Union Star High School
Unionville High School
University City High School
Urbana High School
Ursuline Academy (Arcadia)
Vandalia High School
Versailles High School
Walnut Grove High School
Warrensburg High School
Warsaw High School
Washington High School
Webb City High School
Webster Groves High School
Wellington High School
Wellston High School
Wellsville High School
Wentworth Military Academy (Lexington)
Weston High School
West Plains High School
Wheatland (C. D.) High School
Williamsville High School
Willow Springs High School
Windsor High School
Winona High School
Wyaconda Consolidated High School

CAMPUS VIEW.

MATERIALS TESTING LABORATORY.

CURRICULA AND DEGREES

The School of Mines and Metallurgy offers courses in Mine Engineering, Metallurgy, Civil Engineering, General Science, Mechanical Engineering, Electrical Engineering and Chemical Engineering.

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The curricula are the same in the Freshman year and differ but slightly in the Sophomore year. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

The schedules of studies are planned to take forty-eight hours of the student's time each week, which includes the time in lectures and recitations in the classroom, the time in the laboratory and the time in outside study for recitations.

Three of the forty-eight hours are for physical exercise in Military Drill and in the gymnasium. This physical exercise is compulsory for able-bodied Freshmen and Sophomores and may be elected by Juniors and Seniors.

A student who is physically unfit for military drill may, upon the advice of the Student Health Advisor substitute special work in the gymnasium for the drill.

The student is urged to select, not later than the Sophomore year, some member of the Faculty as an adviser or "big brother." Freshmen and new students should consult the Director until they get acquainted.

The Junior and Senior years are partly required and partly elective. A student in the Mine Engineering curriculum, for example, may wish to take a general course in Mine Engineering or he may wish to take Mining Geology. The required studies are the same for each of these students, but the electives will be different.

The list of electives given for a particular curriculum is suggestive more than compulsory. The student, with the consent of his adviser may, in particular cases, substitute other electives. A thesis may be taken as a Senior elective.

In selecting the electives in the Junior and Senior years, the student must get the approval of his adviser and if he has none, then the approval of the head of the department in which he takes most of his work before filing his schedule of studies.

The student, with the consent of his adviser, may take a schedule containing from forty-two to fifty-four clock hours per week. All schedules with a fewer or a greater number of hours must be approved by the Faculty Committee before being filed. Except in unusual circumstances, this Committee will not approve schedules with the total number of hours outside of the limits of 42 and 54.

Military Science and Tactics are required of all physically fit Freshmen and Sophomores and may be elected by Juniors and Seniors. If the student joins the R. O. T. C., the War Department will furnish his uniform and equipment. If he does not join the R. O. T. C., he must buy his own uniform. To join the R. O. T. C., the student must agree to take two years of military drill in school.

If a student elects to take more than two years in the R. O. T. C., he will take the military science and tactics listed as elective in the Junior and Senior years and some engineering subject of military value approved by the Professor of Military Science and Tactics for his full R. O. T. C. credit.

To receive a degree the student, in addition to completing a curriculum as outlined, must work at least six weeks in an industry in which he is specializing; and students in curricula I, II, or VII must also take a trip of inspection of industrial plants and processes during the Senior year.

The degree of Bachelor of Science in Mine Engineering, Bachelor of Science in Metallurgy, Bachelor of Science in Civil Engineering, Bachelor of Science in General Science, Bachelor of Science in Mechanical Engineering, Bachelor of Science in Electrical Engineering, or Bachelor of Science in Chemical Engineering, will be conferred upon the candidate who has completed all the prescribed work for that particular degree. (For the respective curricula, see pp. — —.) In each instance, the final year's work must be done in residence.

The degree of Master of Science in Mine Engineering, Master of Science in Metallurgy, Master of Science in Civil Engineering, Master of Science in General Science, Master of Science in Mechanical Engineering, Master of Science in Electrical Engineering or Master of Science in Chemical Engineering will be conferred upon a candidate who holds the Bachelor of Science degree in that

particular subject and who has completed, in residence, one year of graduate work and demonstrated his ability by research work and a thesis.

For the degree of Master of Science in General Science, the candidate who is not a graduate of this institution in Curriculum IV must satisfy the language and english requirements of that curriculum.

The degree of Engineer of Mines, Metallurgical Engineer, Civil Engineer, Mechanical Engineer, Electrical Engineer, or Chemical Engineer will be conferred upon a candidate who holds a degree of Bachelor of Science in Mine Engineering, Bachelor of Science in Metallurgy, Bachelor of Science in Civil Engineering, Bachelor of Science in Mechanical Engineering, Bachelor of Science in Electrical Engineering, or Bachelor of Science in Chemical Engineering who has had professional experience in a responsible position for not less than three years. A satisfactory thesis recording the result of some original investigation or independent research in a subject connected with his work, accompanied by such drawings as may be necessary to illustrate it, is required of each candidate for an advanced degree.

A candidate for a professional degree is required to submit list of companies for whom he has worked, with the positions held, the kind of work done, and the length of service.

When a candidate's professional work has been along another line than that in which he received his college training, he may receive the professional degree in that line after five years of practice and by complying with the foregoing statements concerning detailed report of employment and thesis. This applies only to graduates in I, II, III, V, VI, and VII.

Only one professional degree will be allowed for work done *in absentia*.

FIRST YEAR FOR ALL CURRICULA.

Department.	No.	Course.	Hours per week.			
			Lect..	Rec..	Lab..	Prep.
Fall Term.						
Chemistry	1, 2	General Chemistry	2	2	6	2
Civil Engineering	2	Plane Surveying	1	1	6	1
English	1f	Rhetoric and Composition	....	3	....	3
Mathematics	1f	College Algebra	....	3	....	3
Mathematics	3f	Plane Trigonometry	....	2	....	2
Mechanical Engineering	2f	Beginning Drawing	....	....	6	....
Military	1f	Military Science and Tactics	1	1	1	1
Physical Education	....	....	1	....	1	....
Winter Term.						
Chemistry	3, 4	General Chemistry	2	2	3	2
English	1w	Rhetoric and Composition	....	3	....	3
Mathematics	5w	Spherical Trigonometry	....	2	....	2
Mathematics	7w	Analytic Geometry	....	3	....	3
Mechanical Engineering	2w	Mechanical Drawing	1	....	6	1
Mechanical Engineering or Civil Engineering	4w / 4	Forge and Machine Shop / Topographic Surveying	....	....	6	....
Military	1w	Military Science and Tactics	1	1	1	1
Mining	1	Economics of Engineering	....	2	....	2
Physical Education	....	....	....	....	2	....

CURRICULUM I.

Department.	No.	Course.	Hours per week. Lect..	Rec..	Lab..	Prep..
SECOND YEAR.						
First Term.						
Chemistry	7, 8	Analytical Chemistry	2	1	12	2
English	3f	The Short Story	....	2	....	4
Mathematics	9f	Differential and Integral Calculus	....	5	....	5
Military	2f	Military Science and Tactics	1	1	1	1
Physics	1, 2	Mechanics and Heat	2	2	3	3
Physical Education	......	......	....	....	2	....
Second Term.						
Chemistry	10	Quantitative Analysis	....	....	6	....
English	3w	The Novel	....	2	....	4
Geology and Mineralogy	1w	Mineralogy	....	....	9	....
Mechanics	17w	Analytic Mechanics	....	5	....	5
Military	2w	Military Science and Tactics	1	1	1	1
Physics	3, 4	Electricity and Light	2	2	3	3
Physical Education	......	......	....	....	2	....

CURRICULUM I—*Continued.*

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
THIRD YEAR.						
First Term.						
Geology and Mineralogy..	3f	General Dynamic Geology..	....	3	....	6
Geology and Mineralogy..	5f	Lithology................	....	....	6	....
Mechanics.............	19f	Mechanics of Materials.....	....	4	....	4
Mining.................	3, 4	Rock Excavation..........	3	1	3	2
Elective...............	....	Sixteen hours.............	....	....	....	....
Electives.						
Civil Engineering........	9f	Hydraulics................	....	4	3	4
Language..............	....	Modern Language.........	....	5	....	5
Mechanical Engineering..	18f	Machine Shop............	....	....	6	....
Mechanical Engineering..	5f	Elements of Steam Engineering...................	....	3	3	3
Metallurgy.............	1, 4	Assaying.................	2	....	6	1
Military...............	....	Military Science and Tactics	1	1	1	1
Economics.............	....	....	....	....	....	....
Second Term.						
Geology and Mineralogy..	3w	General Structural Geology.	....	3	....	6
Geology and Mineralogy..	4w	Geology Laboratory........	....	....	6	....
Metallurgy.............	7w	Principles of Metallurgy....	....	3	3	3
Mining.................	5, 6	Mine Surveying...........	....	3	6	3
Elective...............	....	Twelve hours.............	....	....	....	....
Electives.						
Civil Engineering........	15w	Stresses..................	....	3	6	3
Civil Engineering........	20w	Materials Laboratory......	....	...	3 or 6	....
Language..............	....	Modern Language.........	....	5	....	5
Military...............	....	Military Science and Tactics	1	1	1	1
Economics.............	....	....	....	....	....	....

CURRICULUM I—*Continued.*

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
FOURTH YEAR. First Term.						
Geology	9f	Economic Geology (Metals)	....	3	....	6
Metallurgy	21f	Ore Dressing	....	3	...3	3
*Elective	....	Thirty hours.				
Electives From						
Civil Engineering	15f	Frame Structures	....	3	6	3
English	19f	Engineering Writing	....	2	....	4
Geology	7f	Geology of United States	....	3	....	6
Geology	11f	Petrography	....	3	9	3
Geology	14f	Field Geology	....	....	6	....
Geology	24f	Stratigraphic Geology	....	3	....	6
Mechanical Engineering	9f	Power Plants	....	3	3	6
Mechanical Engineering	11f	Compressed Air	....	3	3	6
Metallurgy	11f	Metallurgy of Zinc and Copper	3	1	3	3
Metallurgy	13f	Metallurgy Problems	....	3	....	3
Military	4f	Military Science and Tactics	1	1	1	1
Mining	13f	Mine Ventilation	3	1	0	3
Physics and E. E. Economics	7, 8	Principles of Electrical Engineering	....	3	3	3
Second Term.						
Metallurgy	21w	Ore Dressing	....	3	3	3
Mining	11w	Mining	3	1	....	3
*Elective	....	Twenty-nine hours.				
Electives From						
English	19w	Discussion and Debate	....	2	....	4
Geology	9w	Economic Geology (non-metallic)	....	3	....	3
Geology	11w	Petrography	....	3	6	3
Geology	13w	Structural Geology	....	3	....	3
Geology	15w	Geology Conference	....	1	....	2
Geology and Gas	17w	Oil and Gas	....	1	3	1
Mathematics	37w	Mathematics of Energy	....	3	....	3
Mechanical Engineering	15w	Internal Combustion Engines	....	3	3	3
Metallurgy	11w	Metallurgy of Lead and Silver	3	1	3	3
Military	4w	Military Science and Tactics	1	1	1	1
Physics and E. E. Theses	7w	Principles of Electrical Engineering	....	3	3	3

*Students who wish to specialize in coal mining may omit Geology 9f, but must take Geology 9w.

CURRICULUM II.

First year the same as I. Second year the same as I or VII.

Department.	No.	Course.	Hours per week. Lect..	Rec..	Lab..	Prep..
THIRD YEAR.						
First Term.						
Chemistry	41	Physical Chemistry	1	2	6	3
Mechanics	19f	Mechanics of Materials	....	4	....	4
Metallurgy	1, 2	Fire Assaying	2	....	9	1
Electives	....	Sixteen hours.				
Electives From						
Chemistry	23	Organic Chemistry	1	2	6	3
Civil Engineering	20f	Materials Laboratory	....	....	6	....
Geology	3f	General Dynamic Geology	....	3	....	6
Military	3f	Military Science	1	1	1	1
Physics and E. E	7f	Principles of E. E	....	3	3	3
Second Term.						
Chemistry	43	Physical Chemistry	....	2	6	4
Metallurgy	7w	Principles of Metallurgy	....	3	3	3
Metallurgy	9w	Ferrous Metallurgy	....	3	....	3
Electives	....	Twenty-one hours.				
Electives From						
Geology	3w	General Structural Geology	....	3	....	6
Geology	4w	Geology Laboratory	....	....	6	....
Language	3w	Modern Language	....	5	....	5
Military	3w	Military Science	1	1	1	1
Physics and E. E	7w	Principles of E. E	....	3	3	3

CURRICULUM II—*Continued.*

Department.	No.	Course.	Hours per week. Lect..	Rec..	Lab..	Prep.
FOURTH YEAR.						
First Term.						
Metallurgy	11f	Non-ferrous Metallurgy	3	1	3	3
Metallurgy	21f	Ore Dressing	....	3	3	3
Metallurgy	13f	Metallurgy Problems	....	3	....	3
Metallurgy	31f	Alloys and Metallography	....	3	3	3
Elective	....	Fourteen hours.				
Electives From						
English	19f	Engineering Writing	....	2	....	4
Geology	9f	Economic Geology (Metals)	....	3	....	6
Geology	14f	Field Geology	....	....	6	....
Language	....	Modern Languages	....	5	....	5
Military	4f	Military Science	1	1	1	1
Physics and E. E	7f	Principles of E. E	....	3	3	3
Second Term.						
Metallurgy	11w	Non-ferrous Metallurgy	3	1	3	3
Metallurgy	17w	Electro-Metallurgy	....	3	6	3
Metallurgy	21w	Ore Dressing	....	3	3	3
Elective	....	Seventeen hours.				
Electives From						
English	19w	Discussion and Debate	....	2	....	4
Geology and Mineralogy	9w	Economic Geology (Non-Metallic)	....	3	....	3
Language	....	Modern Language	....	5	....	5
Mathematics	37w	Mathematics of Energy	....	3	....	3
Metallurgy	35w	Alloys and Metallography	1	1	6	4
Military	4f	Military Science	1	1	1	1
Physics and E. E	7w	Principles of E. E	....	3	3	3
Theses	....	....	....	....	....	....

CURRICULUM III.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
SECOND YEAR.						
First Term.						
Civil Engineering........	7f	Railroad Surveying........	....	2	6	2
Drawing................	6f	Drawing..................	....	....	3	....
English................	3f	The Short Story...........	....	2	....	4
Geology and Mineralogy..	2f	General Engineering Mineralogy..................	....	....	3	....
Mathematics............	9f	Differential and Integral Calculus..................	....	5	....	5
Military................	2f	Military Science and Tactics	1	1	1	1
Physics.................	1, 2	Mechanics and Heat.......	2	2	3	3
Physical Education......	....	....	....	....	2	....
Second Term.						
Civil Engineering........	13w	Highway Engineering......	....	3	9	3
English................	3w	The Novel................	....	2	....	4
Mechanics..............	17w	Analytic Mechanics........	....	5	....	5
Military................	2w	Military Science and Tactics	1	1	1	1
Physics.................	3, 4	Electricity and Light.......	2	2	3	3
Physical Education......	....	....	....	....	2	....

CURRICULUM III—*Continued.*

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
THIRD YEAR.						
First Term.						
Civil Engineering	9f	Hydraulics	....	4	3	4
Civil Engineering	11f	Masonry	....	3	....	3
Civil Engineering	20f	Materials Testing	....	....	6	....
Mechanics	19f	Mechanics of Materials	....	4	....	4
Electives	....	Nineteen hours.				
Electives From						
Language	....	Modern Language	....	5	....	5
Mechanical Engineering	5f	Elements of Steam Engineering	....	3	3	3
Military	3f	Military Science	1	1	1	1
Mining	3f	Drilling and Blasting	3	1	3	2
Physics and E. E	7f	Principles of E. E	....	3	3	3
Economics	....	....	....	....	....	....
Second Term.						
Civil Engineering	11w	Reinforced Concrete	1	2	6	2
Civil Engineering	15w	Stresses	....	3	6	3
Geology	19w	General Engineering Geology	....	3	....	3
Electives	....	Sixteen hours.				
Electives From						
Civil Engineering	23w	Railroad Economics	....	2	....	2
Geology	4w	Geology Laboratory	....	....	6	....
Language	....	Modern Language	....	5	....	5
Metallurgy	9w	Ferrous Metallurgy	....	3	....	3
Military	3w	Military Science	1	1	1	1
Physic and E. E	7w	Principles of E. E	....	3	3	3
Mechanical Engineering	15w	Internal Combustion Engines	....	3	3	3
Economics	....	....	....	....	....	....

CURRICULUM III—*Continued.*

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
FOURTH YEAR.						
First Term.						
Civil Engineering	15f	Framed Structures	....	3	6	3
Civil Engineering	19f	Water Supply	....	3	....	6
Civil Engineering	31f	Masonry Design	....	3	6	3
Electives	....	Fifteen hours.				
Electives From						
English	19f	Engineering Writing	....	2	....	4
Language	....	Modern Language	....	5	....	5
Mechanical Engineering	5f, 6f	Elements of Steam Engineering	....	3	3	3
Military	4f	Military Science	1	1	1	1
Mining	3f	Drilling and Blasting	3	1	3	2
Second Term.						
Civil Engineering	29w	Sanitary Engineering	....	3	....	6
Civil Engineering	32w	Designing	....	....	9	....
Electives	....	Thirty-three hours.				
Electives From						
Civil Engineering	21w	Irrigation	....	3	....	6
Civil Engineering	23w	Railroad Economics	....	2	....	2
Civil Engineering	39w	Hydraulic Power, Motors and Pumps	....	2	....	4
English	19w	Discussion and Debate	....	2	....	4
Language	....	Modern Language	....	5	....	5
Metallurgy	9w	Metallurgy of Iron and Steel	....	3	....	3
Military	4w	Military Science	1	1	1	1
Bacteriology	....	....	....	....	6	....

CURRICULUM IV.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
SECOND YEAR.						
First Term.						
English	3f	The Short Story	....	2	....	4
Language	....	Modern Language	....	5	....	5
Mathematics	9f	Differential and Integral Calculus	....	5	....	5
Military	2f	Military Science and Tactics	1	1	1	1
Physics	1, 2	Mechanics and Heat	2	2	3	3
Physical Education	....	....	....	....	2	....
Elective	....	Six hours.				
Second Term.						
English	3w	The Novel	....	2	....	4
Language	....	Modern Language	....	5	....	5
Military	2w	Military Science and Tactics	1	1	1	1
Physics	3, 4	Electricity and Light	2	2	3	3
Physical Education	....	....	....	....	2	....
*Elective	....	Sixteen hours.				
THIRD YEAR.						
First Term.						
English	5f	Shakespeare	....	3	....	6
*Elective	....	Thirty-nine hours.				
Second Term.						
English	5w	Contemporary Drama	....	3	....	6
*Elective	....	Thirty-nine hours.				
FOURTH YEAR.						
*Elective	....	Forty-eight hours each term.				

*In making up his electives in Curriculum IV, the student must select a major field and a minor field. In the former, he is required to complete 96 hours and in the latter 48 hours.

The student shall choose his major and minor at the beginning of the second term of the Sophomore Year, and his schedule must be approved by the heads of the departments in whose fields he proposes to study.

CURRICULA V AND VI.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
SECOND YEAR First term						
English	3f	The Short Story	....	....	2	4
Geology	2f	General Engineering Mineralogy	....	....	3	....
Mathematics	9f	Differential and Integral Calculus	....	5	....	5
Mechanical Engineering	18f	Machine Shop	....	....	....	....
Mechanical Engineering	16f	Pattern and Foundry	....	....	6	....
Military	2f	Military Science and Tactics	1	1	1	1
Physics	1, 2	Mechanics and Heat	2	2	3	3
Physical Education	....	....	....	....	2	....
Second Term.						
Chemistry	34	Fuel Analysis	....	....	3	....
Drawing	4w	Machine Drawing	....	....	6	....
English	3w	The Novel	....	2	....	4
Mechanics	17w	Analytic Mechanics	....	5	....	5
Mechanical Engineering	3f	Mechanism	....	3	....	4
Military	2w	Military Science and Tactics	1	1	1	1
Physics	3, 4	Electricity and Light	2	2	3	3
Physical Education	....	....	....	....	2	....

CURRICULA V AND VI—*Continued.*

Department.	No.	Course.	Hours per week. Lect.	Lec.	Lab.	Prep.
THIRD YEAR.						
First Term.						
Mechanics	19f	Mechanics of Materials	....	4	....	4
Mechanical Engineering	5f	Elements of Steam Engineering	....	3	3	3
Mechanical Engineering	20f	Machine Design	....	....	6	....
Physics and E. E	7f	Principles of E. E	....	3	3	3
Electives	....	Sixteen hours.				
Electives From						
Civil Engineering	9f	Hydraulics	....	4	3	4
Civil Engineering	20f	Materials Laboratory	....	....	6	....
Language	....	Modern Language	....	5	....	5
Military	3f	Military Science	1	1	1	1
Physics and E. E	6	Electrical Measurements	....	....	6	....
Second Term.						
Mechanical Engineering	15a	Internal Combustion Engines	....	3	3	3
Mechanical Engineering	9w	Thermodynamics	....	3	....	6
Physics and E. E	7w	Principles o E. E	....	3	3	3
Electives	....	Twenty-one hours.				
Electives From						
Chemistry	43	Physical Chemistry	....	2	6	4
Language	....	Modern Language	....	5	....	5
Mathematics	....	Mathematics of Energy	....	3	....	3
Mechanical Engineering	7w	Valve Gears	....	2	3	3
Mechanical Engineering	20w	Engine Design	....	....	6	....
Metallurgy	9w	Ferrous Metallurgy	....	3	....	3
Military	3w	Military Science	1	1	1	1
Physics and E. E	10w	Electrical Laboratory	....	....	6	....

CURRICULUM V.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
FOURTH YEAR.						
First Term.						
Mechanical Engineering..	9f	Power Plants	....	3	3	6
Mechanical Engineering..	24f	Plant Design	....	....	6	....
Mechanical Engineering..	11f	Compressed Air	....	3	3	6
Elective	....	Eighteen hours.				
Electives From						
English	19f	Engineering Writing	....	2	....	4
Language	....	Modern Language	....	5	....	5
Metallurgy	31f	Alloys and Metallography	....	3	3	3
Metallurgy	21f	Ore Dressing	....	3	3	3
Military	4f	Military Science and Tactics	1	1	1	1
Physics and E. E	11f	Electrical Machinery	....	3	3	3
Second Term.						
Mechanical Engineering..	19w	Industrial Engineering	....	2	....	4
Mechanical Engineering..	17w	Heating and Ventilating	....	3	3	6
Mechanical Engineering..	11w	Refrigeration	....	3	....	6
Elective	....	Twenty-one hours.				
Electives From						
English	19w	Discussion and Debate	....	2	....	4
Language	....	Modern Language	....	5	....	5
Metallurgy	21w	Ore Dressing	....	3	3	3
Military	4w	Military Science and Tactics	1	1	1	1
Physics and E. E	11w	Electrical Machinery	....	3	3	3

CURRICULUM VI.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
FOURTH YEAR.						
First Term.						
Mechanical Engineering	9f	Power Plants	....	3	3	6
Electrical Engineering	11f	Electrical Machinery	....	3	3	3
Electrical Engineering	13f	Alternating Currents	....	3	....	6
Electives	....	Eighteen hours.				
Electives From						
English	19f	Engineering Writing	....	2	....	4
Language	....	Modern Language	....	5	....	5
Metallurgy	21f	Ore Dressing	....	3	3	3
Military	4f	Military Science	1	1	1	1
Physics and E. E	15	Wireless Communication	....	2	....	4
Elect ical Engineering	21f	Electric Railways	....	3	....	6
Second Term.						
Electrical Engineering	11w	Electrical Machinery	....	3	3	3
Electrical Engineering	13w	Alternating Currents	....	3	....	6
Electrical Engineering	19w	Electrical Distribution	....	3	6	3
Electives	....	Eighteen hours.				
Electives From						
English	19w	Discussion and Debate	....	2	....	4
Language	....	Modern Language	....	5	....	5
Metallurgy	17w	Electro-Metallurgy	....	3	6	3
Metallurgy	21w	Ore Dressing	....	3	3	3
Military	4w	Military Science	1	1	1	1

CURRICULUM VII.

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
SECOND YEAR.						
First Term.						
Chemistry	7	Analytical Chemistry	2	1	12	2
English	3f	The Short Story	....	2	....	4
Mathematics	9f	Differential and Integral Calculus	....	5	....	5
Military	2f	Military Science and Tactics	1	1	1	1
Physics	1, 2	Mechanics and Heat	2	2	3	3
Physical Education	....	....	....	....	2	....
Second Term.						
Chemistry	10	Quantitative Analysis	....	....	6	....
Chemistry	21	Organic Chemistry	2	1	6	2
English	3w	The Novel	....	2	....	4
Mechanics	17w	Analytic Mechanics	....	5	....	5
Military	2w	Military Science and Tactics	1	1	1	1
Physics	3, 4	Electricity and Light	2	2	3	3
Physical Education	....	....	....	....	2	....

CURRICULUM VII—*Continued.*

Department.	No.	Course.	Hours per week. Lect.	Rec.	Lab.	Prep.
THIRD YEAR.						
First Term.						
Chemistry	41	Physical Chemistry	1	2	6	3
Chemistry	23	Organic Chemistry	1	2	6	3
Geology and Mineralogy	1f	Crystallography	....	....	3	....
Language	7	Elementary German	....	5	....	5
Elective	....	Eleven hours.				
Electives From						
Civil Engineering	20f	Materials Laboratory	....	....	3 or 6	....
Mechanical Engineering	5, 6	Elements of Steam Engineering	....	3	3	3
Military	3f	Military Science	1	1	1	1
Mechanics	19f	Mechanics of Materials	....	4	....	4
Economics	....	....	....	....	....	....
Second Term.						
Chemistry	43	Physical Chemistry	....	2	6	4
Chemistry	51	Industrial Chemistry, General Processes	1	2	6	3
Language	9	Scientific German	....	5	....	5
Metallurgy	1, 6	Assaying	2	....	3	1
Elective	....	Eight hours.				
Electives From						
Chemistry	12	Advanced Quantitative Analysis	....	....	6	....
Mathematics	37	Mathematics of Energy	....	3	....	3
Metallurgy	7w	Principles of Metallurgy	....	3	3	3
Metallurgy	9w	Ferrous Metallurgy	....	3	....	3
Military	3w	Military Science	1	1	1	1
Economics	....	....	....	....	....	....

CURRICULUM VII—*Continued.*

DEPARTMENT.	NO.	COURSE.	Hours per week. Lect..	Rec..	Lab..	Prep.
FOURTH YEAR.						
FIRST TERM.						
Chemistry..............	53	Industrial Chemistry, Inorganic....................	....	2	6	4
Chemistry..............	57	Chemical Industries........	1	2	3	2
Elective................	....	Twenty-eight hours.				
SECOND TERM.						
Chemistry..............	55	Industrial Chemistry, Organic......................	....	2	6	4
Elective................	....	Thirty-six hours.				

Electives may include any courses for which the prerequisites have been completed, subject to the approval of the Chemistry department and the Professor of the course in question.

THESES

Seniors may elect, subject to the approval of the head of the Department, to carry on special investigations embodying the results of their work in a thesis. The subject of the thesis must be reported to the Thesis Committee of the Faculty and approved not later than January tenth. The completed thesis must be filed with the Director not later than April fifteenth.

The finished thesis should be typewritten (or printed) on eight and one-half by eleven-inch paper, written on one side only. The paper should be strong linen, unruled and without marginal lines.

The thesis should be typewritten so as to have a margin all around of not less than one and one-half inches.

Thesis paper should not be punched with holes for staples.

Thesis, when submitted, should not be stapled, sewed, or bound in any manner, but should be on loose sheets, in order that all theses may be bound uniformly by the Library.

Drawings, tracings, blue prints, diagrams, statistical tables, etc., when on a single 8½x11 inch sheet, should allow a margin of at least 1½ inches on the inner (long) edge, for binding purposes. When on a larger sheet, requiring folding, large margin should be allowed on all sides, and drawings should not be folded but submitted flat or rolled, in order that they may be properly folded and adjusted by the binder. It is suggested that students confer with the Librarian in regard to the preparation of drawings, diagrams, tracings, etc.

The thesis should have:

(1) A title page containing the subject of the thesis, the writer's name, and the date. It should show the approval of the professor under whose direction the work has been done and should also state the degree for which the candidate is an applicant.
(2) A table of contents.
(3) A list of illustrations.
(4) The body of the thesis, including illustrations.
(5) A bibliography.
(6) An index.
(7) Original drawings or tracings.

All theses submitted by candidates for degrees become the property of the School of Mines and Metallurgy and may not be published without its approval.

GRADUATE COURSES

The School of Mines offers graduate work in Mining Engineering, Metallurgy, Ore Dressing, Geology, Economic Geology, Petrography, and Advanced Chemistry. The attention of graduates of engineering schools and of mining schools is directed to the following courses:

Mine Management
Mining Machinery
Mining Machinery Laboratory
Mining Law
Mine Examination and Reports
Mine Plant
Mine Plant Design
Mine Power Plant
Mining Economics
Economic Geology
Geology of the United States
Structural and Metamorphic Geology
Petrography
Petrography Laboratory
Cement and Concrete Structures
Compressed Air
Compressed Air Laboratory
Engineering Designs
Ore Dressing Laboratory
Ore Dressing Problems
Ore Supply
Metallurgy Organization
Metallography
Constitution of Alloys
Metallurgical Problems
Metallurgical Plant
Metallurgical Plant Design
Cyaniding
Electro-Metallurgy
Electro-Metallurgy Laboratory
Metallurgical Research
Electro-Chemistry
Water Analysis
Physical Chemistry
Theoretical Chemistry
Advanced Physico-Chemical Laboratory
Internal Combustion Engines

CHEMISTRY BUILDING.

CAMPUS VIEW.

SPECIAL COURSES

In addition to the regular curricula leading to degrees, before mentioned, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying, and Electricity.* They have been planned for the benefit of those who for various legitimate reasons are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* equires two years' work, although mature students, who have already some knowledge of chemistry, may complete it in one year.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draftsmen. The essentials of it are a thorough knowledge of algebra, trigonometry, surveying, field practice, and drawing. One school year and the first term of a second year will be required for the completion of this course.

A short course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides mathematics, this course includes general chemistry, assaying, mineralogy, mining, surveying and English.

A course in *Electricity* is offered to furnish the student with the theory of electricity and acquaint him with its application in the arts. This subject is of great importance to every engineer, especially to the mining engineer, since electricity has become such an important factor in mining operations.

VOCATIONAL COURSES

The Federal Board for Vocational Education sends ex-soldiers to the School of Mines for training. Some of these students go into the regular courses. For others who have not had the requisite preliminary training, special two-year structural, mechanical and electrical courses have been established.

CHEMISTRY

PROFESSOR TURNER, ASSOCIATE PROFESSOR SHAW, ASSISTANT PROFESSORS DUNLAP AND STERNBERG, MR. LANE, MR. WEISER, MR. KERSHNER, MR. HOWALD, MR. TERRY, MR. NUDELMAN, MR. BADOLLET, MR. FISCHLOWITZ, MR. WHEELER.

Equipment.

One entire building is devoted to chemistry. The freshman chemical lecture room is situated in the south wing of the building. The laboratories for general chemistry, on the first floor of the main building, accommodate together about one hundred sixty students. The quantitative laboratories on the second floor have desk room for seventy-five students working at one time. In the north wing is a smaller lecture room, as well as a capacious laboratory for industrial chemistry and a small commercial analytical laboratory.

Excellent ventilation is provided by a thirteen-horsepower motor and suction fan connected with individual hoods over each laboratory desk and with the fume chambers distributed throughout the building. Gas, water, and air blast are supplied conveniently, while a steam-heated still of five gallons an hour capacity furnishes ample distilled water.

The equipment includes twenty-six first-class analytical balances, seventy sets of good analytical weights, sixty sets of volumetric instruments with Bureau of Standards stamps, several complete sets of gas analysis apparatus, standard instruments for the physical and chemical testing of petroleum and its products, a liberal supply of platinum ware, and a good selection of precision instruments for physico-chemical and electro-chemical measurements.

The department has secured the co-operation of some of the chemical manufacturing concerns and has prepared for exhibition a Museum of Industrial Chemistry. Exhibits of the raw material and products illustrating the processes in many of the industries are displayed.

An Industrial Laboratory with adequate machinery and accessories is being installed in the north wing of the Chemical Building. The machines installed include a vacuum pan, steam kettles, mixing machines, filter presses, apparatus for distillation and rectification, grinding machinery, and the incidentals necessary for

the preparation of commercial chemicals, soap, paints, wood products, acids, oils, etc.

With the proposed rearrangement of the building more space will be available for laboratory work in organic, physical, and electro-chemistry, as well as in the applied chemistry.

Courses.

1. GENERAL CHEMISTRY. (Turner)

This course is a comprehensive study of the general principles of chemistry and of the more important non-metals. The fundamental laws of chemistry are developed in logical order, special attention being given to their application in practical computations. Carefully designed lecture experiments are a feature of the course. The class is divided into several smaller sections for recitation and discussion of problems.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, two lectures, two recitations, two hours' preparation per week.

Text: Alexander Smith, *General Chemistry for Colleges.*
Smith & Moore, *Chemical Calculations.*

2. GENERAL CHEMISTRY.
(Turner, Lane, Weiser and Nudelman)

The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

Prerequisite: Must be accompanied by Chemistry 1.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, six hours per week.

Text: *Mimeograph Notes.*
Alexander Smith, *Laboratory Manual of General Chemistry.*

3. GENERAL CHEMISTRY. (Turner)

Continuation of course 1; devoted to the chemistry of the metals, with special consideration of the reactions employed in analytical chemistry, in metallurgy, and in geology. The ionic theory, phase rule, and mass-law are introduced and applied at advantageous points in the lectures.

Prerequisites: Chemistry 1 and 2.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, second term, two lectures, two recitations, two hours' preparation per week.

Text: Same as in 1.

4. GENERAL CHEMISTRY.
(Turner, Lane, Weiser and Nudelman)

This is a continuation of 2.
Required in I., II., III., IV., V., VI., and VII.
Freshman year, second term, three hours per week.
Texts: Same as for 2.

7. ANALYTICAL CHEMISTRY. *Lectures.* (Sternberg)

The first twelve periods will be devoted to a discussion of Qualitative Analytical methods. During the remainder of this course the following subjects will be discussed:—The balance, weights, and the process of weighing; simple gravimetric analysis; volumetric instruments, their calibration and use; volumetric analysis, standard solutions, and indicators.

Problems in the calculations of analytical chemistry are also discussed.

Prerequisites: Chemistry 3 and 4. To be accompanied by Chemistry 8.

Required in I., II., and VII.

Sophomore year, first term, two lectures, one recitation, two hours' preparation per week.

Text: Steiglitz, *Qualitative Chemical Analysis.*
Manuscript Notes.

8. ANALYTICAL CHEMISTRY. *Laboratory.*
(Sternberg, Howald and Terry)

The student will devote the first eight weeks to the qualitative separation and detection of the metals.

The application of the principles of Quantitative Analysis as illustrated in the simpler Gravimetric and Volumetric determinations will then be taken up.

It is purposed in this course to lay a broad foundation of analytical principles upon which the student may build up by subsequent practice.

Prerequisites: To be accompanied by Chemistry 7.

Required in I., II., and VII.

Sophomore year, first term, twelve hours per week.

Text: Blasdale, *Quantitative Analysis.*
Manuscript Notes.

10. QUANTITATIVE ANALYSIS.
(Sternberg, Howald and Wheeler)

Technical methods for the determination of copper, lead, zinc, arsenic, antimony, sulphur, and coal analysis. Essential parts of the course are the speed tests, in which students are required to

report correct results on a number of copper, zinc, and lead ores within a stated time.

Actual ores, analyzed by the instructing staff, are on hand in quantity, and the students are trained to attain the same degree of accuracy which obtains in smelter laboratories.

Prerequisite: Chemistry 8.
Required in I., II. and VII.
Sophomore year, second term, six hours per week.
Text: Low, *Ore Analysis.*

12. INDUSTRIAL ANALYSIS. *Laboratory.* (Sternberg)

General methods in industrial analysis, the course being designed to illustrate principles, with the intention of developing the ability to select methods, and to adapt them when occasion demands.

Prerequisites: Chemistry 10 and 22.
Elective in VII.
Six hours per week.

14. MINERAL ANALYSIS. *Laboratory.* (Sternberg)

This course is offered primarily for students who desire to become acquainted with the methods of analysis of matters, speisses, crude and refined lead and copper bullion, spelter, alloys, and similar material. No required schedule is laid out.

Prerequisite: Chemistry 10.
Elective.
Six hours per week.

16. WATER ANALYSIS. *Laboratory.* (Sternberg)

This course is designed to meet the wants of engineering students. Sanitary water analysis and boiler water analysis are offered, although students interested in geology may substitute mineral water analysis for some of the work.

Prerequisite: Chemistry 10.
Elective, second term, six hours per week.

18. ORGANIC ANALYSIS. *Laboratory.* (Sternberg)

A laboratory course in the analysis of commercial products.
Prerequisites: Chemistry 10 and 22.
Elective, six hours per week.

21. ORGANIC CHEMISTRY. (Dunlap)

The course is an introduction to the simple organic compounds. Special emphasis is placed on the structure and nomenclature of the aliphatic series.

Prerequisite: Chemistry 7.
Required in VII.
Sophomore year, second term, one lecture, two recitations, two hours' preparation per week.
Text: Cohen, *Theoretical Organic Chemistry.*

22. ORGANIC CHEMISTRY. *Laboratory.* (Dunlap)

Preparation and purification of typical aliphatic compounds, illustrating general methods of synthesis and technique of manipulations.
Prerequisite: Must be accompanied by Chemistry 21.
Required in VII.
Sophomore year, second term, six hours a week.
Text: Cohen, *Practical Organic Chemistry.*

23. ORGANIC CHEMISTRY. (Dunlap)

A continuation of 21, extending the consideration to the aromatic compounds.
Prerequisite: Chemistry 21.
Required in VII.
Junior year, first semester, two lecture, one recitations, three hours' preparation per week.
Text: As above.

24. ORGANIC CHEMISTRY. *Laboratory.* (Dunlap)

A continuation of 22, illustrating important synthetic processes for typical aromatic compounds, together with a study of the conditions of reactions.
Prerequisites: Accompanies Chemistry 23.
Required in VII.
Junior year, first semester, six hours a week.
Text: Cohen, *Practical Organic Chemistry.*

25. ADVANCED ORGANIC CHEMISTRY. (Dunlap)

A general review of the whole field of the aliphatic and aromatic compounds, followed by an intensive study of some phase of industrial organic manufacture. Lectures, assigned reading, recitations, and reports on the manufacture of special organic products such as dyes, rubber, cellulose, sugars, etc.
Prerequisite: 23.
Elective in VII.
First term, one lecture, two recitations, three hours' preparation week.

26. ADVANCED ORGANIC CHEMISTRY. *Chemistry.* (Dunlap)

Advanced preparations followed by intensive study of some problems selected for the special needs and ability of the student.

Prerequisite: To be accompanied by 25.

Elective in VII.

First term, six hours per week.

27. ORGANIC PROCESSES. *Lectures.* (Dunlap)

Lectures, assigned readings, and reports on such processes as oxidation, reduction, sulfonation, esterification, etc.

Prerequisite: 25.

Elective, second term, two lectures, one recitation, three hours preparation per week.

28. ORGANIC PROCESSES. *Laboratory.* (Dunlap)

Work to accompany 27. Students are assigned special problems according to their training and fitness.

Prerequisite: To be accompanied by 27.

Elective, second term, six hours per week.

31. GENERAL PRINCIPLES OF CHEMISTRY. *Lectures.* (Turner)

A course designed to correlate the prerequisite inorganic, analytical, organic, physical and industrial courses and to give training in the application of the general principles of chemistry through the solution of various problems.

Prerequisite: Chemistry 57.

Elective, Senior year, second semester, three recitations, five hours preparation per week.

34. FUEL AND GAS ANALYSIS. *Laboratory.* (Sternberg and Weiser)

A more or less practical course in fuel and gas testing especially adapted to the needs of the Mechanical and Electrical Engineer.

Prerequisite: Chemistry 4.

Required in V. and VI.

Sophomore year, second term, three hours per week.

Text: Gill, *Engine Room Chemistry.*

35. ENGINEERING CHEMISTRY. (Turner)

In this course are taken up in order the chemistry of fuels, industrial waters, lubricants, building materials, lime and cement, paving and wood preservation, paints and varnishes, and explosives.

One hour per week is devoted to reports by the students on topics of interest gleaned from the industrial journals.

Prerequisite: Chemistry 7.

Elective, first term, three recitations and six hours' preparation per week.

Text: Benson, *Industrial Chemistry.*
Manuscript Notes.

41. PHYSICAL CHEMISTRY. (Sternberg)

While some attention is paid to the application of physical methods of chemistry, and the qualitative and quantitative theories of chemical equilibria as given by the phase rule and the mass law, the special stress in this course is laid on the study of the effects of the equilibrium factors on chemical reactions.

Prerequisites: Chemistry 7, Physics 3w and 4w. To be accompanied by Chemistry 42.

Required in II. and VII.

Junior year, first term, one lecture, two recitations, three hours' preparation per week.

Text: Lewis, *A System of Physical Chemistry.*
Manuscript Notes.

42. PHYSICAL CHEMISTRY. *Laboratory.* (Sternberg)

Laboratory to accompany Chemistry 41.

Prerequisites: Same as 41.

Required in II. and VII.

Junior year, first term, six hours per week.

Text: Findlay, *Practical Physical Chemistry.*

43. PHYSICAL CHEMISTRY. (Sternberg)

A study of the theories of electrolysis, conductance of electrolytes, electromotive force, polarization. A continuation of 41.

Prerequisites: Chemistry 41, Physics, 4f.

Required in II. and VII.

Junior year, second term, two recitations, four hours' preparation per week.

Text: LeBlanc, *Electro-Chemistry.*

44. PHYSICAL CHEMISTRY. *Laboratory.* (Sternberg)

Measurements of conductivity, electromotive force, resistance single potentials; electro-deposition of metals, electro-analysis. A continuation of Chemistry 42.

Prerequisite: Must be accompanied by Chemistry 43.

Required in II. and VII.

Junior year, second term, six hours a week.
Texts: Findlay, *Practical Physical Chemistry.*
Watts, *Laboratory Course in Electro-Chemistry.*

45. ADVANCED PHYSICAL CHEMISTRY. (Sternberg)

A discussion of physico-chemical topics such as: phase rule, osmosis, hydrolysis, transference, etc.

Prerequisite: Chemistry 43.

Elective, senior year, first term, two recitations, four hours' preparation per week.

47. THE CHEMISTRY OF COLLOIDS. (Sternberg)

A review of the development of the theory of colloids, together with laboratory demonstrations to illustrate the modern practice in the study of the subject.

Prerequisite: Chemistry 43.

Elective on approval of the instructor, senior year, second term, one lecture, three hours' demonstration or preparation.

48. INDUSTRIAL ELECTRO-CHEMISTRY. *Laboratory.* (Sternberg)

A laboratory course in the construction, testing and operation of primary and storage cells; preparation of inorganic and organic compounds by means of electrolysis; electroplating.

Prerequisite: Chemistry 44.

Elective, six hours per week.

51. INDUSTRIAL CHEMISTRY GENERAL PROCESSES. (Dunlap)

A survey of the classification of chemical literature, followed by a study of the types of plant and apparatus used in chemical operations.

Prerequisite: Chemistry 23.

Required in VII.

This course must be accompanied by Chemistry 52.

Junior year, second term, one lecture, two recitations, three hours' preparation per week.

Text: Rogers, *Industrial Chemistry.*
Kremann-Potts, *Applications of Physico-Chemical Theory.*
Manuscript Notes.
Reference.

52. INDUSTRIAL CHEMISTRY GENERAL PROCESSES. *Plant.* (Dunlap, Lane, Badollet)

This course is designed to accompany the lectures in General Industrial Chemistry and to give the student an opportunity to revise his pre-acquired knowledge to fit large-scale operations.

The manipulation of the apparatus studied in the classroom is carried out with reference to its adaptability in typical operations.

This course must be accompanied by Chemistry 51.

Required in VII.

Junior year, second term, six hours per week.

Text: Rogers, *Laboratory Guide of Industrial Chemistry.*
Manuscript Notes and Blue Prints.
Reference Works.

53. INDUSTRIAL CHEMISTRY, INORGANIC. (Dunlap)

A study of typical inorganic chemical industries.

Required in VII.

Prerequisite: Chemistry 51.

Senior year, first term, two recitations, four hours' preparation per week.

Text and Reference: *References.*
Manuscript Notes and Blue Prints.

54. INDUSTRIAL CHEMISTRY, INORGANIC. *Plant.* (Dunlap, Lane, Badollet)

The industrial preparation of typical inorganic products.

Prerequisite: Chemistry 52.

This course must be accompanied by Chemistry 53.

Senior year, first term, six hours per week.

Text and References: As above.

55. INDUSTRIAL CHEMISTRY, ORGANIC. (Dunlap)

A study of typical organic chemical industries.

Prerequisite: Chemistry 53.

This course must be accompanied by Chemistry 56.

Senior year, second semester, two recitations, four hours' preparation per week.

Text and References: *References.*
Manuscript Notes and Blue Prints.

56. INDUSTRIAL CHEMISTRY, ORGANIC. *Plant.* (Dunlap)

The industrial preparation of typical organic products.

Prerequisite: Chemistry 54.

This course must be accompanied by Chemistry 55.
Senior year, second semester, six hours per week.
Text and Reference: As above.

57. CHEMICAL INDUSTRIES. (Turner)

The course consists of lectures and reading assignments on the following topics: Effect of economic conditions on location of chemical plants, price and value of products, markets, labor, industrial insurance, legislation relating to the exportation, importation, manufacture, transport and use of chemicals, and the exploitation of chemical ideas.

Prerequisite: Chemistry 51.
Required in VII.
Senior year, first term, one lecture, two recitations and two hours preparation per week.
Text: Ely, *Outlines of Economics.*
Manuscript Notes.

58. CHEMICAL ENGINEERING DATA. *Laboratory.* (Turner)

To supplement the work described in Chemistry 57. To consist mainly of individual study in the collection and interpretation of data concerning the administrative as well as the scientific side of Chemical Manufacturing.

Prerequisite: Chemistry 52.
First term, three hours per week.

61. GENERAL BACTERIOLOGY. *Lectures.* (Shaw)

This course deals with general bacteriology and with the relation of bacteria to the public health.

Prerequisite: Chemistry 10.
Elective.
First term, two lectures, two hours' preparation.

62. GENERAL BACTERIOLOGY. *Laboratory.* (Shaw)

The laboratory course to accompany Course 61. The work deals with the preparation of media, cultural and staining methods, diagnostic tests, and the examination of the more common bacteria.

Prerequisite: Chemistry 10.
Elective.
First term, four hours' laboratory per week.

64. BACTERIOLOGY OF FOODS. *Laboratory.* (Shaw)

The laboratory examination of milk, oysters, meats, water, etc.

Prerequisite: Chemistry 62.

Elective.

Second term, six hours' laboratory per week.

90, 92, 94. SENIOR PROBLEMS. *Laboratory.*
(Turner, Dunlap, Sternberg)

For senior students who show special aptitude, a number of original problems are usually available. These problems require close attention to laboratory work, and consistent search in the literature, and should be elected only by students who intend to follow research in pure or applied chemistry. For such men, this course serves as introductory to independent work.

Prerequisites: Chemistry 43 and 51.

Elective, twelve hours per week.

CIVIL ENGINEERING

PROFESSOR HARRIS, ASSOCIATE PROFESSORS McCANDLISS AND ARMSBY, MR. STUBBINS, MR. COLBERT, MR. SCHUMACHER,† MR. BARDSLEY,† MR. WRIGHT.*

The Department of Civil Engineering has its lecture rooms, drafting rooms, offices and department library in Norwood Hall. The hydraulics laboratory and the locker rooms for field equipment are in the Power Plant Building.

The Laboratory for Testing Materials and the Cement Testing Laboratory, together with office, supply and computation rooms, occupy almost the entire ground floor of Parker Hall.

The plan of study is designed to afford such training that the graduates will be prepared to perform at once the minor duties in the various branches of the profession. Especial stress is laid upon proficiency in field work, drafting and the design and inspection of the more common engineering structures.

For field work the department is equipped with twenty transits, five of which are complete mining instruments with side and top telescopes, and fifteen wye and dumpy levels, representing the principal makes and types of construction. Additional equipment includes a solar compass, a surveyor's compass, three geologist's compasses, four Brunten transits, thirteen plane tables, two sextants, and a liberal supply of hand levels, barometers, clinimeters, dip-needles, angle prisms, chains, tapes, level rods, stadia rods, range poles, etc.

The field work is so outlined that the student has an opportunity to judge the relative merits of the various types of field instruments.

An important feature of the instrument room is the locker system. Due to the scope of the equipment it has been possible to arrange in separate lockers complete equipment for each surveying squad.

For the hydrographic field work the department is liberally equipped with current meters, gauges, floats, etc.

The hydrographic work is not outlined with the regularly catalogued courses but is given as a special course for Seniors in the

†First term.
*Second term.

School of Civil Engineering. The work is usually conducted on the Gasconade river.

The department has at its disposal three well-equipped drafting rooms.

The laboratory for testing materials is equipped with one 200,000-pound capacity universal testing machine of the Olsen type, which is capable of testing specimens eight feet long in either tension or compression, and specimens in cross bending 16 feet long between supports. It also contains two machines, each of 50,000-pound capacity, of the Riehle type, which are used for testing small speciments in tension, compression and cross-bending; one 60,000 inch-pound capacity torsion machine of the Olsen type, and one machine used for demonstration of the action of levers, and for testing small speciment in cross bending. All machines in this laboratory are direct connected motor driven. The necessary small equipment, such as extensometers, compressometers, etc., is ample for the needs of the classes, and comprises only the most modern types of instruments.

This laboratory affords facilities for: Research in the design and the methods of failure of structures, the study of the physical characteristics and composition of materials, and the determination of the laws controlling the behavior of stressed and unstressed members.

The cement testing laboratory is equipped for making complete physical tests of cement, concrete and concrete aggregates, and for investigations of the proper proportioning of concrete. The equipment consists of two standard tension testing machines; two Vicat apparatus; several specific gravity apparatus; one electric drying oven; one standard steamer; an autoclave; a moist closet; apparatus for the determination of specific gravity of, and voids in, concrete aggregate; several sets of standard sieves; standard cylindrical molds for concrete; and an ample supply of standard tension briquette molds, graduates, trowels, spatulas and other small apparatus.

Courses.

2. PLANE SURVEYING. *Lectures and Laboratory.*
(Armsby, Stubbins, Colbert, Schumacher, Bardsley)

The theory and practice of Plane Surveying, including the adjustments and uses of transits, levels, and minor instruments; land surveying; traverses; leveling; determination of meridian; mapping; and the usual computations used in connection with Plane Surveying. The notes taken in the field are used for computation and mapping, helping to emphasize the practical nature of the work done, and also affording a check on the field work.

The simpler problems are conducted on and about the campus, the work being referenced to stations of a triangulation system, the bearings and lengths of sides of which have been accurately determined, thus affording checks on the accuracy of the student work.

Prerequisites: To be accompanied or preceded by Mathematics 1f and 3f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, one lecture, one recitation, one hour preparation and six hours' field work per week.

4. TOPOGRAPHIC SURVEYING. *Laboratory.*
(Armsby, Stubbins, Wright)

A continuation of the work given in Civil Engineering 2, with the addition of some of the simpler astronomical observations, base line measurements, triangulation, stadia and plane table work, road traversing, and other problems. A complete topographical map of a small area is made.

Prerequisites: Civil Engineering 2.

Required in III.; option in other curricula.

Freshman year, second term, six hours per week.

7f. RAILROAD SURVEYING. (McCandliss)

This course is a study of the theory of simple, compound, and reverse curves; frogs and switches; turnouts and crossovers, and earthwork. The laboratory periods are devoted to the solution of typical problems, and are conducted in the field so far as the weather permits.

Prerequisite: Civil Engineering 4.

Required in III.

Second year, first term, two recitations, six hours laboratory, two hours preparation per week.

9f. HYDRAULICS. (Harris)

The theory of hydrostatics and of hydraulics, and its application to the dependent problems in engineering practice; determination of empirical coefficients and their application in determining the flow of water through orifices, weirs, pipes, canals, and rivers.

Prerequisite: Mechanics 17w.

Required in III.

Junior year, first term, four recitations, three hours laboratory and four hours preparation per week.

11f. MASONRY CONSTRUCTION. *Lectures.* (Armsby)

The object of this course is to study the fundamental principles underlying the selection, testing, preparation, and use of the various building materials in masonry structures. The treatment of ordinary and pile foundations, foundations under water, dams, retaining walls, piers, abutments, and culverts are successively taken up and studied.

Prerequisites: Mechanics 17w. To be accompanied by Mathematics 19f.

Required in III.

Junior year, first term, three recitations and three hours preparation per week.

11w. REINFORCED CONCRETE. (Harris)

This course covers the theory and design of concrete-steel beams, slabs, tanks, dams, culverts, conduits, retaining walls, and columns.

Prerequisites: Mechanics 19f and Civil Engineering 11f.

Required in III.

Junior year, second term, two recitations, six hours laboratory and two hours preparation per week.

13w. HIGHWAY ENGINEERING. (Armsby)

This course is designed to prepare the student for positions of minor responsibilities in Highway Engineering. It treats of the character and types of common roads and pavements; the types of minor highway structures; the testing of materials for highway construction and the study of approved plans, specifications and estimates. A complete relocation of an existing highway is made and from this plans are prepared and an estimate of cost is outlined.

Prerequisite: Civil Engineering 2.

Required in III.

Sophomore year, second term; three recitations, three hours preparation, nine hours laboratory per week.

15f. FRAMED STRUCTURES. *Lectures and Laboratory.* (McCandliss)

This course is a continuation of Civil Engineering 15w and covers the complete design, with estimates and bills of materials of plate girders, bridges, roofs, towers, steel building frames and the like.

Prerequisite: Civil Engineering 15w.

Required in III.

Senior year, first term, three recitations, six hours laboratory and three hours preparation per week.

15w. STRESSES. *Lectures and Laboratory.* (McCandliss)

This course covers the graphic and analytic determination of stresses in the simpler engineering structures under their various loads, including derricks, roof trusses, and single-span bridges.

Prerequisites: Mechanics 17w, 19f.

Required in III.

Junior year, second term, three recitations, six hours laboratory and three hours preparation per week.

19f. WATER SUPPLY. *Lectures.* (McCandliss)

This course covers the selection, storing, transporting, purification, and delivering of water to cities and towns.

Prerequisites: Civil Engineering 9f and 11w.

Required in III.

Senior year, first term, three recitations and six hours preparation per week.

20f. MATERIALS TESTING LABORATORIES. *Laboratory.* (McCandliss)

In this course the student's time is divided between the cement testing laboratory and the laboratory for testing materials. Early in the semester the work consists of making complete physical tests of standard brands of natural and Portland cements, and the effects of such adulterants as free lime, sulphur acids and alkalies upon the strength and durability of the same. The laws governing the proportionment of concretes, and mortars, are verified experimentally.

Tests are conducted to show the relationship of strength to density in mortars and concrete; the effect of fineness of grinding of a cement on its setting properties; the effect of clay upon the strength and density of concrete; the effect of commercial waterproofing ingredients upon the porosity of concrete, and such other determinations as are appropriate to a laboratory of this character. The entire course is designed to impress the student with economic truths, the adaptability and the limitations of the use of mortars and concretes for materials of engineering construction.

The latter part of the semester is devoted to the physical tests in tension, compression, flexure and torsion of such materials as iron, steel, timber, stone, brick and other clay products; the study of the behavior of these materials under stress and the interpretation of the results of the investigations.

Prerequisite: Mathematics 15f.

Required in III.

Junior year, first term, six hours per week.

21f. IRRIGATION AND DRAINAGE ENGINEERING.
Lectures. (Harris)

The time here allotted is given to the study of special problems arising in the design of irrigation projects, such as location of the main canal and its head work, mapping the lands, locating the secondary canals, special methods of measuring and delivering the water, necessary water consumption, etc., and to the study of the cause and control of foods, protection of river banks, improvements of navigation, and protection and improvement of harbors.

Prerequisites: Civil Engineering 9f and 11w.

Elective.

Senior elective, first term, three recitations and six hours preparation per week.

23w. RAILROAD ECONOMICS. (Armsby)

This course treats of the economic principles of the locations, revision, operation, and financing of railroads. The scope of the work covers train resistances under varying conditions of traffic, grade and curvature; locomotive performance; valuation of railroad properties; grade separation, etc.

Prerequisite: Civil Engineering 7f.

Senior year, second term, two recitations and two hours preparation per week.

29w. SANITARY ENGINEERING. (McCandliss)

Treats of the precautions necessary to protect water supplies from pollution and the methods available for the purification of sewage; also the construction of sewer systems for the collection and transportation of sewage and storm water.

Prerequisite: Civil Engineering 19f.

Required in III.

Senior year, second term, three recitations, six hours preparation per week.

31f. MASONRY DESIGN. (Harris)

This course is a logical continuation of Civil Engineering 11w. It includes the analysis and design of high masonry dams, reinforced concrete dams, long-span arches, stacks, and the like. A portion of the time is given to tunneling and difficult foundations.

Prerequisite: Civil Engineering 11w.

Required in III.

Senior year, first term, three recitations, six hours laboratory and three hours preparation per week.

32w. DESIGNING. *Laboratory.* (Harris)

The work in this course is selected to accord with the line of work in which the student expects or desires to specialize. He is required to find his material in the library, and to inform himself as to the best current practice relative to the problem assigned. Throughout this semester the student is required to keep informed as to the current Civil Engineering literature.

Prerequisites: Civil Engineering 17f and 31f.

Required in III.

Senior year, second term, nine hours per week.

39w. HYDRAULIC POWER, MOTORS AND PUMPS. (Harris)

This course is a logical continuation of the course in Hydraulics (9f). It includes the theory of hydraulic motors and centrifugal pumps; the various problems of water power development on rivers; and the economic effect of water storage on water power and the control of floods.

Prerequisite: 9f.

Elective, two recitations, four hours' preparation.

DRAWING

Associate Professor Wallis, Mr. Nolte, Mr. Boyle, Mr. Loesche, Mr. Zieseniss, Mr. Wills.

The south side of the third floor in Norwood Hall is given over to the work in Engineering Drawing. This includes three drafting rooms, an office and a blue-printing room.

The drafting rooms are equipped with seventy-five double and thirty-two single drawing desks, these being arranged to accommodate individually the drawing boards, tee-squares and instruments of each student in drawing. In addition, locker accommodations are available for fifty-four students.

The blue-printing room is equipped with a Pease vertical electric-printing machine, a Pease wall-print washer, a large frame mounted on a rolling carriage for sun printing, a specially designed paper-cutting table, as well as small printing frames and other miscellaneous equipment.

The aims of the general courses in Drawing are three-fold: First, to so drill the student in the preparation of simple exercises and detail drawings that sufficient proficiency is attained in the use of drafting instruments and in free-hand lettering to enable him to prepare neat and creditable drawings. Second, to give the student a thorough understanding of the principles of projection as applied to engineering drawing. Third, to teach each student the various commercial methods of reproducing drawings, principally blue printing.

Courses.

2f. BEGINNING DRAWING. *Laboratory.*
(Wallis, Nolte, Boyle)

By means of a carefully-graded series of exercises and simple drawings, the student is drilled in the correct use of drafting instruments, special emphasis being placed on the production of work of quality rather than of quantity. The student is carefully drilled in the correct formation of the standard style of free-hand single-stroke lettering used on engineering drawings, in the fundamental principles of orthographic projection, in the correct meth-

ods of dimensioning simple details drawn to scale, and in the making of blue prints from certain of his tracings.

Prerequisites: Entrance requirements.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, first term, six hours laboratory per week.

2w. ADVANCED DRAWING. *Laboratory.*
(Wallis, Boyle, Loesche, Wills)

This course covers the fundamental principles of projective drawing, with special reference to their application to engineering drawing, and includes the following general topics: Lines, surfaces, theory of orthographic projection, intersections and developments, isometric projection, oblique projection, perspective projection, and some special work in free-hand outline sketching of machine parts in orthographic and in perspective projection. The text is supplemented by drafting-room lectures, which are given at the beginning of each laboratory period.

Weekly quizzes are given covering the drafting-room lectures and problems of the preceding week.

Prerequisite: Drawing 2f.

Required in I., II., III., IV., V., VI., and VII.

Freshman year, second term, one lecture, six hours laboratory and one hour preparation per week.

4w. MACHINE DRAWING. *Laboratory.* (Wallis, Nolte)

The work of this course familiarizes the student with drafting room conventions as applied to machine drawing, and is intended to prepare him as to drafting technique for the advanced work in machine design.

Prerequisites: Drawing 2f and 2w.

Required in V. and VI.

Sophomore year, second term, six hours laboratory per week.

6f. TOPOGRAPHICAL DRAWING. *Laboratory.*
(Wallis, Zieseniss)

This course covers certain special needs of the civil engineering student in free-hand lettering for maps and titles, topographical symbols, special drafting conventions, and the drawing of maps and plans for simple engineering structures.

Prerequisites: Civil Engineering 2 and 4, Drawing 2f and 2w.

Required in III.

Sophomore year, first term, three hours laboratory per week.

Elective Courses in Drawing.

Certain elective courses in drawing are in course of preparation and, while they cannot conveniently be given course numbers in this catalogue, they are listed below for the convenience of such students as may desire to take advanced work in drawing.

These courses are offered tentatively for the school year 1920-21, subject to the demand. Such students as may be interested in any of these courses should confer with the head of the Department of Drawing:

Advanced Machine Drawing—one laboratory.
Advanced Topographical Drawing—one laboratory.
Tinting and Shading—one laboratory.
Architectural Shades and Shadows—one laboratory.
Elements of Structural Drawing—one laboratory.
Drafting-Room Management—two lectures.
Formula Charting—one lecture and one laboratory.
Graphical Presentation—one lecture.
Drawing for Reproduction—one lecture and one laboratory.

CAMPUS VIEW.

CAMPUS VIEW.

ENGLISH AND MODERN FOREIGN LANGUAGES

PROFESSOR BARLEY, ASSISTANT PROFESSORS DANIELS AND JOHNSON, MR. WALSH, MR. LLOYD.

ENGLISH.

1f. RHETORIC AND COMPOSITION. *Lectures.* (Johnson)

A study of the theory of exposition, with especial attention to the paragraph and to the correct and the effective sentence. A reasonable amount of written work is required of the student in order that he may gain facility in the use of clear, idiomatic English. In many instances this written work is drawn from other sources pursued by the student, thereby correlating his practice in composition with his immediate interests and activities.

Prerequisites: College entrance requirements in English.

Required in all courses.

Freshman year, first term, three recitations and three hours' preparation per week.

1w. RHETORIC AND COMPOSITION. *Lectures.* (Johnson)

This course is a continuation of 1f. Attention is given to the theory of punctuation and to the writing of long themes. Some outside reading is required.

Prerequisite: 1f.

Required in all courses.

Freshman year, second term, three recitations and three hours' preparation per week.

3f. THE SHORT STORY. *Lectures.* (Barley)

An extended reading course in selected short stories, together with a critical study of representative specimens of this literary type.

Prerequisites: English 1f and 1w.

Sophomore year, first term, two recitations and four hours' preparation per week.

3w. THE NOVEL. *Lectures.* (Barley)

A reading course in representative English and American novels of the nineteenth century and of the present day.

Prerequisites: English 1f and 1w.

Sophomore year, second term, two recitations and four hours' preparation per week.

23f. MASTERPIECES. *Lectures.* (Barley)

Critical study of selected literary masterpieces.

Prerequisites: English 1f and 1w.

Sophomore year, first term, two recitations and four hours' preparation per week.

23w. AMERICAN LITERATURE. *Lectures.* (Barley)

An advanced course in the history and development of literature in the United States, with particular reference to the period following the Civil War.

Prerequisites: English 1f and 1w.

Sophomore year, second term, two recitations and four hours' preparation per week.

Either 3f or 23f and either 3w or 23w are required of Sophomores in all courses.

5f. SHAKESPEARE. *Lectures.* (Barley)

Five or six of Shakespeare's plays are carefully studied in class and several more are required as collateral reading.

Prerequisites: Sophomore requirements in English.

Required in Curriculum IV.

Junior year, first term, three recitations and six hours' preparation per week.

5w. CONTEMPORARY DRAMA. *Lectures.* (Barley)

A reading course in the drama of the present day, supplemented by lectures.

Prerequisites: As in 5f.

Required in Curriculum IV.

Junior year, second term, three recitations and six hours' preparation per week.

19f. ENGINEERING WRITING. *Lectures.* (Barley)

An advanced course in oral and written technical reports and in the details and problems of engineering writing.

Senior year, first term, two recitations and four hours' preparation per week. Elective. Open to Juniors.

19w. DISCUSSION AND DEBATE. *Lectures.* (Barley)

The primary aim of the course is to give students training in clear and logical oral expression. Contemporaneous topics of engineering and of general interest will be discussed and debated.

Senior year, second term, two recitations and four hours' preparation per week. Elective. Open to Juniors.

MODERN FOREIGN LANGUAGES.

The modern foreign languages offered are French, German, and Spanish. Twenty hours of German are required in Curriculum VII., and twenty hours of either German or French are required in Curriculum IV. Languages are elective in Curricula I, II, III, V, and VI.

At present the United States Geological Survey requires French or German in its civil service examinations. Students who expect to qualify for this work are advised to elect one or both of these languages.

Students who expect to engage in work in Central America or South America are advised to elect Spanish.

No advanced standing will be given for high school credits in language except by examination.

7. ELEMENTARY GERMAN. *Lectures.*

First term, five recitations and five hours' preparation per week.

Required in Curriculum VII. Required also in Curriculum IV unless French is elected.

9. SCIENTIFIC GERMAN. *Lectfires.* (Daniels)

Prerequisite: German 7.

Second term. Five recitations and five hours' preparation per week.

Required in Curriculum VII. Required also in Curriculum IV unless French is elected.

11. ELEMENTARY FRENCH. *Lectures.* (Daniels)

First term, five recitations and five hours' preparation per week.

Required in Curriculum IV unless German is elected. Elective in all other curricula.

13. SCIENTIFIC FRENCH. *Lectures.* (Daniels)

Prerequisite: French 11.
Second term, five recitations and five hours' preparation per week.
Required in Curriculum IV unless German is elected.

15. ELEMENTARY SPANISH. *Lectures.* (Daniels)

First term, five recitations and five hours' preparation per week.
Elective in all curricula.

17. COMMERCIAL SPANISH. *Lectures.* (Daniels)

Prerequisite: Spanish 15.
Second term, fiive recitations and five hours' preparation per week.
Elective in all curricula.

GEOLOGY AND MINERALOGY.

PROFESSOR COX, ASSOCIATE PROFESSOR DAKE, ASSISTANT PROFESSOR MUILENBURG, MR. RACKETT, MR. NETZEBAND.

Equipment.

The geological and mineralogical laboratories are on the second floor of Norwood Hall. They are supplied with suitable tables for the examination of rocks and minerals. The equipment of the department includes reference, working, and cabinet collections of minerals, ores, rocks, and fossils and many specimens illustrating metallurgical processes; a working collection of wooden and glass crystal models and natural crystals; full set of maps and reports and a set of geological relief models.

There is also a collection of thirty-five hundred specimens representing the mineral wealth of Missouri, consisting of coal, clays of many sorts, building stones, and ores of lead, zinc, iron and copper. The minerals occurring as gangue with the metalliferous deposits of the state are also well represented. There is also a complete collection of the economic minerals of Missouri and a good economic geological collection representing the world at large. This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago and was presented to the School of Mines and Metallurgy by the General Assembly in 1895.

In addition to the above-mentioned collection, the State Board of Equalization assigned to the school the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the school a large amount of valuable equipment.

The museums contain crystals and minerals from various parts of the world, the important mining districts of the State of Missouri being especially well represented by the economic collection from Southwestern Missouri, the great geological relief map, polished stone tables and ornamental stones, and other complete collections of the Missouri Building of the St. Louis Exposition.

Rock-breaking and section machines, instruments for geological surveys, petrographic microscopes, thin mineral and rock sections, and lantern slides are included in the equipment of this department.

1f. CRYSTALLOGRAPHY. *Lectures and Laboratory.*
(Muilenburg, Rackett)

Elementary crystallography, including the study of models and natural crystals, with oral and written recitations. The chief object of the course is to give the student an understanding of the general principles of crystallography and the ability to recognize crystal forms, especially the systems, by the use of few, if any, instruments. The necessary lectures are given during the regular laboratory time.

Required in VII.

Junior year, first term, three hours' laboratory per week.

Text: Butler, *Geometrical Crystallography.*

1w. MINERALOGY. *Lectures and Laboratory.*
(Muilenburg, Rackett)

A study of the fundamental principles of classification and the distinctive characteristics of minerals, with a thorough drill in the recognition of about one hundred and seventy-five species. This includes the determination of unknowns by means of the blowpipe and only those principles of crystallography which are essential in the study of minerals.

Prerequisites: Chemistry 1w, 3w and 4w.

Required in I. and in IV. with Geology major.

Sophomore year, second term, nine hours' laboratory work per week.

Texts: Dana, *Textbook of Mineralogy.*
Butler, *Handbook of Mineralogy.*

2f. GENERAL ENGINEERING MINERALOGY.
Lectures and Laboratory. (Muilenburg)

A study of the common ore and rock-forming minerals and types of rocks. The necessary lectures are given during the regular laboratory periods. This course is intended for the Civil, Mechanical, Electrical, and Chemical Engineering students, the same ground being covered more thoroughly by Course 1f, 1b and 5w, so that full credit may not be given for it and one or more of these courses, and it may not be substituted for any part of them.

Prerequisite: Chemistry 1w.

Required in III.

Sophomore year, first term, three hours per week.

11f. OPTICAL MINERALOGY. (See Geology 11f.)

GEOLOGY.

Courses.

3f. GENERAL GEOLOGY. *Lectures.* (Dake)

Dynamic geology. A somewhat detailed account of geologic processes. The larger topics are treated more exhaustively than in the required text. Local field trips.

Prerequisites: Either 2f or 1w.

Required in I., and in IV. with Geology major.

Junior year, first term, three recitations and six hours' preparation per week.

Text: Cleland, *Geology, Physical and Historical.*

3w. GENERAL GEOLOGY. *Lectures.* (Dake)

Introductory structural and historical geology. Typical geologic structures and their effects upon the physiographic development of the earth's surface are considered for the first eight weeks. Geologic history is then traced from the beginning of the record to the present, as much attention as possible being paid to the rock systems and their contained fossils, with some reference to geographic changes and organic evolution.

Prerequisites: Geology 3f. To be accompanied by Geology 4w.

Required in I., and in IV. with Geology major.

Junior year, second term, three recitations and six hours' preparation per week.

Text: Cleland, *Geology, Physical and Historical.*

4w. GENERAL GEOLOGY. *Laboratory.* (Dake)

Laboratory exercises in reading topographic and geologic maps; in the construction of profile and geologic sections and simple geologic maps. These exercises are designed to illustrate the subject-matter of the earlier lectures of Course 3w, and occupy nine weeks; excursions and field practice in elementary geologic mapping the remainder of the semester.

Prerequisite: Geology 3f. To accompany Geology 3w.

Required in I., and in IV. with Geology major.

Junior year, second term, six hours per week.

References: Hayes, *Handbook for Field Geologists.*
Geikie, *Structural and Field Geology.*
Prof. Paper, *U. S. Geol. Survey No.* 60.

5f. LITHOLOGY. *Lectures and Laboratory.* (Muilenburg)

A study of the structure, texture, mineral and chemical composition, and the manner of formation and occurrences of igneous, sedimentary, and metamorphic rocks. This course is adequate for all general field determinations.

Prerequisites: Mineralogy 1w; to be accompanied by Geology 3f.

Required in I., and in IV. with Geology major.

Junior year, first term, six hours of laboratory work per week.

Text: Kemp, *Handbook of Rocks.*

7f. GEOLOGY OF THE UNITED STATES. *Lectures.* (Dake)

The physiography, stratigraphy, economic products, and geologic structure and history of the chief geologic divisions of the United States are summarized in the lectures.

Prerequisites: Geology 3w, 4w, and either 2f or 5f.

Required in IV. with Geology major.

Senior year, first term, three recitations and six hours' preparation per week.

Text: Blackwelder, *Handbook of Regional Geology, the United States.*

9f. ECONOMIC GEOLOGY. *Lectures.* (Cox)

A study of the origin, occurrence, and distribution of the metallic ores. Various type deposits of the world are considered, special attention being given to those of the United States. Written reports are required for each district studied; reference always being made to the original reports, thus familiarizing the student with the various technical publications and their usage. The ores of the following metals are considered: zinc, lead, copper, gold, silver, nickel, cobalt, iron, manganese, tin, mercury, tungsten, platinum, and aluminum. Trips to local points of interest.

Candidates for the degree of Bachelor of Science in Mine Engineering or Metallurgy taking this course must also take the geology part of Course 12, Senior Trip.

Prerequisites: Geology 3w, 4w, and either 2f or 5w.

Required in I. with General Mining or Geology options, and in IV. with Geology major.

Senior year, first term, three recitations and six hours' preparation per week.

Text: No text required. Reference largely to reports by the United States and state geological surveys.

9w. ECONOMIC GEOLOGY. *Lectures.* (Cox, Muilenburg)

A study of the origin, occurrence, and distribution of the economic deposits of the non-metals. Reference is made to those technical reports which describe the most important deposits, and a written summary is required for each district studied. The subjects covered are as follows: coal, oil and gas, clays, cements, gypsum, salt, sulphus, sulphides, building stone, abrasives, gems, soils, and fertilizers. Trips to local points of interest.

Students taking this course who do not take Course 12 will be given special work while the remainder of the class is taking the Senior Trip.

Prerequisites: Geology 3w, 4w, and either 2f or 5f.

Required in I. with Geology or with Coal Mining option, and in IV. with Geology major.

Senior year, second term, three recitations and three hours' preparation per week.

Text: No text required. Reference largely to reports of the United States and state geological surveys.

11f. PETROGRAPHY. *Lectures and Laboratory.* (Muilenburg)

The semester is devoted to the study of optics as applied to the determination of minerals by the polarizing mic oscope, the identification of minerals in thin sections, and the grinding of rock and mineral thin sections.

Prerequisites: Geology, 3w, 4w, and 5w, and Physics 3w and 4w; to be accompanied by Mineralogy 1f.

Senior year, first term, three lectures and nine hours of laboratory work and three hours' preparation per week.

Text: Luquer, *Minerals in Rock Sections.*

11w. PETROGRAPHY. *Lectures and Laboratory.* (Muilenburg)

A study of nomenclature, relations and alterations of rocks, together with the petrographic analysis and the recalculation of the chemical analysis of rocks.

Prerequisite: Geology 11f.

Senior year, second term, three lectures and six hours of laboratory work and three hours' preparation per week.

Texts: Kemp, *Handbook of Rocks,* with one of the following:
Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannson, *Determination of Rock-Forming Minerals.*

12. SENIOR TRIP. (Cox)

During the second semester of the Senior year a three weeks' trip is taken to Joplin, St. Louis, Flat River, and other points in the Southeastern Missouri Lead District, for the purpose of studying mining, ore dressing, smelting, geology, and power plants of these districts. The geology portion of these trips is required of all candidates for the degrees in Mining Engineering and Metallurgy who have taken Course 9f.

Prerequisite: Geology 9f.

Senior year, second term.

13w. STRUCTURAL GEOLOGY. *Lectures.* (Cox)

An advanced course in the study of rock deformation, including a review of the theories of the origin of the earth; a discussion of the zones of rock fracture and rock flowage; a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates, and pseudo-conglomerates; and a consideration of mountain-building forces, together with the horizontal and vertical depth affected, with application to special districts.

Prerequisites: Geology 3w, 4w, and either 2f or 5f.

Required in I. with Geology option, and in IV. with Geology major.

Senior year, second term, three recitations and six hours' preparation per week.

14f. FIELD GEOLOGY. *Field Work.* (Cox, Dake, Rackett)

The course consists of both field and laboratory work, the two being varied to suit the weather. The field work consists of the making of topographic and geologic maps, with suitable sections. and reports, of assigned areas. The laboratory work includes the making of sections and maps and the final drafting of the field work.

The instruments used include the plane table, hand level, aneroid barometer and telescopic alidade.

Prerequistes: Geology 3w, 4w, and either 2f or 5f.

Required in I. with Geology option and in IV. with Geology major.

Senior year, first term, six hours per week.

15w. GEOLOGY CONFERENCE. (Cox)

The conference consists of a discussion by the students and instructors of geologic problems and literature, each student being assigned certain work upon which he must report to the class.

Prerequisite: Geology 9f.

Senior year, second term, one hour recitation and two hours' preparation per week.

16w. ADVANCED GEOLOGY. *Laboratory.* (Dake)

An advanced course in the study and interpretation of topographic and geologic maps.

Prerequisites: Geology 3w and 4w.

Required in IV. with Geology major.

Senior year, second term, nine lectures and ninety hours' laboratory work for the semester.

17f. OIL AND GAS. *Lectures.* (Cox)

A detailed study of the origin and occurrence of the various oil and gas deposits.

Prerequisites: Mineralogy 1w or 2f and Geology 3w.

Senior year, first term, one recitation and two hours' preparation per week.

17w. OIL AND GAS. *Lectures.* (Cox)

Field methods in petroleum geology.

Prerequisite: Geology 17f.

Senior year, second term, one recitation and two hours' preparation per week.

18w. OIL AND GAS. *Laboratory.* (Cox)

Laboratory work in connection with Course 17w, and in the interpretation and preparation of maps.

Prerequisites: Must be accompanied by Geology 17w and 4w.

Senior year, second term, three hours per week.

19w. GENERAL ENGINEERING GEOLOGY. *Lectures.* (Dake)

An introductory course in general geology adapted to the general needs of students in Civil, Mechanical, Electrical and Chemical Engineering. The work covers general geology with such detail as is possible in the time allowed.

Prerequisite: Mineralogy 2f.

Required in III.

Junior year, second term, three recitations and three hours' preparation per week.

Text: Ries and Watson, *Engineering Geology.*

24f. STRATIGRAPHIC AND METAMORPHIC GEOLOGY.
Lectures. (Muilenburg)

An advanced course in stratigraphic and metamorphic geology, special emphasis being given to sedimentation.

Prerequisites: Geology 3w, 4w and 5f.

Senior year, first term, three recitations and six hours' preparation per week.

40. SPECIAL GEOLOGY.

Special studies in geology, hours and subjects to be arranged with each student.

MATHEMATICS

PROFESSOR DEAN, MR. HINSCH, MR. BARDSLEY,
MR. CUNNINGHAM, MR. RACKETT.

While the utility of mathematical study as a mental discipline is duly recognized, the ultimate intention of the student is kept in mind, and the matter and methods of the courses are adjusted, as nearly as possible, to meet the demands of subsequent studies and professional practice.

Courses.

1f. COLLEGE ALGEBRA. (Hinsch, Cunningham, Rackett)

A review of the principles of elementary algebra, and a study of those parts of advanced algebra that are necessary to prepare the student for the study of calculus.

Required in all curricula.

Freshman year, first term, three recitations and three hours' study per week.

Text: Hall and Knight, *Algebra for Schools and Colleges.*

3f. PLANE TRIGONOMETRY. (Hinsch, Cunningham)

Solution of plane triangles, reduction and transformation of trigonometric expressions, solutions of trigonometric equations.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, first term, two recitations and two hours' study per week.

Text: Taylor and Puryear, *Trigonometry.*

5w. SPHERICAL TRIGONOMETRY.
(Hinsch, Bardsley, Cunningham)

Continuation of Mathematics 3f, taking up more difficult parts of analytical trigonometry, solution of spherical triangles, and simpler problems of spherical astronomy.

Prerequisite: Mathematics 3f.

Required in I., II., III., IV., V., VI. and VII.

Freshman year, second term, two recitations and two hours' study per week.

Text: Phillips, *Trigonometry.*

7w. ANALYTICAL GEOMETRY.

(Hinsch, Cunningham, Rackett)

The object of this course is to familiarize the student with methods rather than with any particular set of curves. Special attention, however, is given to those forms of the equations of the conic sections which occur in technical literature.

Prerequisite: Mathematics 5w.

Required in all curricula.

Freshman year, second term, three recitations and three hours' study per week.

Text: Phillips, *Analytic Geometry.*

9f or 9w. DIFFERENTIAL AND INTEGRAL CALCULUS.

(Dean, Hinsch, Bardsley)

Derivation of formulae and application of derivatives in the solution of problems in rates, velocity, acceleration, curve tracing and maximadele and minima. Integration of forms occurring in mechanics, physics, and chemistry. Evaluation of areas, moments, moments of inertia, determination of centers of gravity, and center of pressure. Differential equations of mechanics and physics, and their application in solution of problems in physics.

Required in all curricula except General Science.

Prerequisites: Mathematics 1f, 3f, 5w, 7w.

Sophomore year, first or second term, five recitations and five hours' study per week.

Text: Phillips, *Calculus.*

11f or 11w. ADVANCED CALCULUS. (Dean)

This course is designed for students who desire preparation for advanced theoretical work in physics and chemistry.

Prerequisites: Mathematics 1f, 3f, 5w, 7w, 9f or 9w.

Elective, five recitations and five hours' study per week.

Text: Wilson, *Advanced Calculus.*

37. MATHEMATICS OF WORK AND ENERGY (Dean)

General dynamics, hydrodynamics, thermodynamics, theory of electricity and magnetism, theory of optics.

Elective, three recitations per week, two lectures and three hours' study.

Prerequisites: Mathematics 9f or 9w, 11f or 11w.

Texts: Christiansen, *Theoretical Physics.*
Houstoun, *Mathematical Physics.*
Perkins, *General Thermodynamics.*
Starling, *Electricity and Magnetism.*

MECHANICS

ASSOCIATE PROFESSOR GARRETT.

17w. MECHANICS. (Garrett)

The first half of the semester is devoted to statics. It is the aim of the course to train the student in the application of fundamental principles to practical problems. The second half of the semester is given to kinematics and kinetics with technical applications.

Prerequisites: Mathematics 9.

Required in I., II., III., V., VI. and VII.

Sophomore year, second term, five recitations and five hours' study per week.

Text: Poorman, *Applied Mezhanics.*

19f. MECHANICS OF MATERIALS. (Garrett)

A general course in the mechanics of materials. As the subject is developed the student is given a thorough drill in the application of principles to simple problems of design and in the use of standard handbooks.

Prerequisite: Mechanics 17w.

Required in I., II., III., V. and VI.

Junior year, first term, four recitations and four hours' study per week.

Text: Houghton, *Mechanics of Materials.*
Notes by instructor.

21w. ADVANCED MECHANICS OF MATERIALS. (Garrett)

This course begins with a more advanced study of certain parts of the work covered in Mechanics 19f and includes further a discussion of such subjects as combined stresses, inertia circle and ellipse, kern, beams of unsymmetrical section, curved beams, flat plates and thick cylinders.

Prerequisite: Mechanics 19f.

Elective, second term, six hours per week.

23f. ADVANCED MECHANICS. *Lectures.* (Garrett)

This course is designed primarily as a senior elective in curriculum V. or VI. While the subject-matter of the course is selected with reference to the needs of the class and may vary somewhat from year to year, it is for the most part along lines suggested by the following topics: Periodic Motion, Whirling Shafts and Rotating Discs, Vibration, Balancing.

Prerequisite: Mechanics 19f.

Elective, first term, six hours per week.

MECHANICAL HALL.

POWER PLANT.

MECHANICAL ENGINEERING

Professor Dickerson, Assistant Professor Bowen, Mr. Underwood, Mr. Sherwood, Mr. Corey.

The course for Juniors and Seniors in Mechanical Engineering are conducted in the lecture and drafting rooms in Norwood Hall; the experimental laboratories are located in the Power Plant Building and the drawing and shop practice are given in Mechanical Hall.

Equipment.

The power plant is used for experimental purposes, and comprises a modern equipped laboratory. The machinery available for testing purposes includes four 130-h. p. Heine safety boilers, especially equipped with openings in the setting for temperature and draft measurements in furnace, combustion chamber and flues; a 13 by 14 Erie Ball engine direct connected to a 75 kw. 220-volt D. C. Westinghouse generator; a 10 by 12 Ideal engine direct connected to a 50-kw. 220-volt D. C. Westinghouse generator; a 12 by 11 General Electric marine-type engine direct connected to a 50-k. v. a. 220 volts, 60-cycle, three-phase generator with direct connected exciter; a 10-kw. 220-volt Curtis steam turbo generator; a six-stage 36-h. p. Kerr steam turbine complete with Prony brake on the same bed plate; a 9 by 14 Brownell engine equipped with a rope-friction brake; a 5 by 7 Davis and Rankin vertical engine equipped with a Prony brake; a 21-h. p. Otto four strokes per cycle gas engine belted to a two-stage Worthington ecntrifugal pump; a 3-h. p. Ferro two strokes per cycle portable gas engine; a 8-h. p. K.-E. Bessemer gas engine equipped to run on either gasoline or crude oil; a 6H Continental automobile motor arranged for testing; a D. C. switchboard with a panel for each generator and two for distribution switches, equipped with a Tirrill voltage regulator, a Thompson recording watt-hour meter, circuit breakers for each generator, and the usual ammmeters and voltmeter; an A. C. switchboard with voltmeter, ammeters, wattmeter and watt-hour meter. The pneumatic equipment includes a Laidlow-Dunn-Gordon air compressor, a Rand Imperial air compressor, a Sullivan straight-line two-stage air compressor, a 72-inch ventilating fan, a 36-inch ventilating fan, a 60-inch Buffalo forge blower, an experi-

mental fan capable of delivering 250 cu. ft. of air per second at six inches of water pressure, two cylindrical steel tanks 6 ft. by 15 ft. for measuring air by water displacement.

The Ball and Ideal engines; also the air compressors and steam turbines are connected to a 20-inch shell Griscom-Russell surface condenser with a Blake vacuum pump.

The laboratory also contains a complete Wickes vertical boiler and engine ten horsepower plant fitted for testing purposes.

There is a complete steam and pumping plant at the experimental mine, where laboratory practice is also obtained.

The instrument room of the Mechanical Laboratory contains a good line of instruments used for testing purposes, some of which are listed below.

Parr and Roland-Wild coal calorimeters; Ellison throttling and evaporating moisture calorimeters; Peabody, and Schaeffer and Budenberg moisture calorimeters; General Electric Co., and Gebhart portable steam flow meters; Hays, and Orsat flue gas apparatus; Crosby, Thompson, Robertson, Schaeffer and Budenberg, and American steam and gas engine indicators; Schaeffer and Budenberg continuous drum indicator; Amsler, Crosby, Willis, and Keuffel and Esser planimeters; various indicating and recording steam gauges; Crosby steam gauge testers; Tycos portable pyrometer; cold and hot-water meters; thermometers, manometers, tachometers and speed counters; and Prony friction brakes.

The shops are thoroughly equipped with machinery and benches adapted to instruction. The wood bench-work room contains twenty double benches with separate sets of hand tools. The lathe room is equipped with twenty Fay & Egan 12-in. swing college wood lathes and iron shears. The other machines in the lathe room include a Fay & Egan 27-in. planer, a Fay & Egan band saw with 30-in. wheels, Fay & Egan joiner, an Oliver universal saw-table, two Oliver wood trimmers, a mortise machine, jig saw, grindstones, and other necessary tools.

For instruction in forge work there are twenty-four Buffalo Forge Company down-draft forges, power hammer, drill press, power shears, and grinder.

The metal-working room contains:

One 20-in. by 8-ft. Reed lathe.
One 12-in. by 6-ft. Reed lathe.
One 14-in. by 6-ft. Hendey lathe.
One 14-in. by 6-ft. American lathe.
Four 13-in. by 5-ft. South Bend lathes.
One No. 2A Brown & Sharpe universal milling machine.
One No. 2 universal Norton grinder.
One Hendey 15-in. pillar shaper.
One Dwight sensitive drill.
One Barnes 22-in. swing upright drill press.

One 24-in. Morse double emery grinder.
One 24-in. by 24-in. by 6-ft. Chandler planer.
Two Greenard arbor presses, No. 3½ and No. 1.
One No. 1 Burr cold saw.
One 3-fire Chicago flexible shaft gas furnace.
One portable Buffalo forge.

All of the above-mentioned iron-working machinery is of latest design and driven by individual motors. The benches in the lathe room have hardwood tops mounted on standard Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work. Also a standard portable oxy-acetylene welding and cutting outfit of the latest type is included in the shop equipment.

3f. MECHANISM. *Lectures.* (Dickerson)

In this course are studied the principles which underlie the action of the elementary combinations of which all machines are composed, also the motions and velocities of linkages, cams, and gears.

Prerequisites: Mechanical Engineering 4f and 18w.
Required in V. and VI.
Junior year, first term, three hours per week.
Text: Keown, *Mechanism.*

4w. FORGE AND MACHINE SHOP. (Bowen, Underwood)

Required in V., VI., and optional in I., II., IV. and VII.
Freshman year, second term, six hours a week.

5f. BOILERS AND ENGINES. *Lectures.* (Dickerson)

This course takes up the consideration of the construction and operation of the various well-known types of boilers and engines and their accessories. Under the boiler part is included chimneys and boiler settings; under the engine part is included the simple and multi-expansion Corliss engines, uniflow engines, steam turbines, and gas engines.

Prerequisites: Physics 1f, 2f.
Required in V. and VI.
Junior year, first term, three recitations and three hours' preparation per week.
Text: Spanger, Green and Marshall, *Elements of Steam Engineering.*

6f. STEAM LABORATORY. *Laboratory.*
(Dickerson, Sherwood)

A laboratory course given to familiarize the student with the instruments used in engineering investigations, also to give training in securing data, reporting, and analyzing results obtained from experiments conducted on boilers and steam and gas engines.

Prerequisite: To accompany Mechanical Engineering 5f.

Required in V. and VII.

Junior year, second term, three hours per week.

7w. VALVE GEARS. *Lectures and Problems.* (Dickerson)

The study of valve gears is essentially a study of the relative motions and simultaneous positions of the piston, crank and valve of an engine. This course deals principally with the valve and valve diagrams, shaft governor, Corliss and poppet valve gears and the reversing gears as applied to steam engines.

Prerequisites: Mechanical Engineering 3f and 5f.

Required in V.

Junior year, second term, two recitations, three hours' laboratory and three hours' preparation per week.

Text: Fessenden, *Valve Gears.*

8w. MECHANICAL LABORATORY. *Laboratory.*
(Dickerson, Sherwood)

A course similar to Mechanical Engineering 6w. This course also includes experiments on air compressors.

Prerequisite: To accompany Mechanical Engineering 5f.

Junior year, second term, six hours per week.

9f. POWER PLANTS. *Lectures and Laboratory.* (Dickerson)

This course attempts to cover the broad scope of classifying the various types of machines used in power plants according to their adaptability to service, space, economy, and cost; also to give the student some idea of the commercial side of engineering.

A laboratory period gives opportunity for studying the general lay-outs and operation of power plants and also experimental data which is obtained from complete plant tests.

Prerequisites: Mechanical Engineering 5f and 6w.

Required in V. and VI.

Senior year, first term, three recitations, three hours' laboratory and six hours' preparation per week.

Text: Fernald & Orrok, *Engineering of Power Plants.*

FORGE SHOP.

MACHINE SHOP.

9w. THERMODYNAMICS. *Lectures.* (Dickerson)

A course in theoretical thermodynamics, covering the laws and fundamental equations of gases and their application to the steam engine. Also a discussion of the principles governing the action of air compressors, gas engines, refrigerating machines and steam turbines.

Required in V. and VI.

Junior year, second term, three recitations and six hours' preparation per week.

Text: Moyer and Calderwood, *Engineering Thermodynamics.*

11f. COMPRESSED AIR. *Lectures.* (Harris)

This course covers the theory of air compression, both in reciprocating machines and in centrifugal machines; also the measurement and transmission of air, and its application to the industries.

The problems include laboratory work in testing compressors and fans, determination of friction in pipes, flow through orifices, and the solution of problems, such as come up in practice.

Prerequisites: Mathematics 19f, Mechanical Engineering 5f and 6w.

Required in V.

Senior year, first term, three recitations, three hours' laboratory and six hours' preparation per week.

Text: Harris, *Compressed Air.*

12f or w. WOOD WORK. *Laboratory.* (Davidson)

The work in the wood shop aims to train the student in the use of wood-working tools and machinery and to familiarize him with the properties of the common woods. All work is done from drawings. One hour of period is spent in explanations and demonstrations of both wood and metal-working shop methods.

Freshman year, first term, six hours per week.

14f. FORGE WORK. *Laboratory.* (Underwood)

This course begins with simple exercises in drawing, upsetting, bending, twisting, punching, and welding. The work gradually becomes more difficult, such as making eye-bolts, chains, and tongs. Tool-making is then begun by making screwdrivers, hammers, chisels, and a complete set of lathe tools to be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. The student is made familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting

iron, steel, brass and stone. The final part of this work is the testing of rock-drills on different grades of steel used.

Sophomore year, second term, three hours per week.

15w. INTERNAL COMBUSTION ENGINES. *Lectures.* (Dickerson)

This course includes the theory of internal combustion engines, as well as the construction and operating features of the various types of automobile, stationary oil engines of small sizes, Diesel and other engines of large type. The gas producer is also studied.

Required in V. and VI.

Junior year, second term, three recitations, three hours' laboratory and three hours' preparation per week.

Text: Sterling, *Internal Combustion Engines.*

16f. FOUNDRY. *Laboratory.* (Bowen)

This course comprises instruction and practice in the use of foundry tools and equipment and in tempering of sand, preparation of sands for core binding and core making. It also includes bench, floor, pit, sweep, and machine molding; charging of cupola and pouring of metals.

Prerequisites: Mechanical Engineering 12f and 14w.

Required in V. and VI.

Sophomore year, first term, six hours per week.

17w. HEATING AND VENTILATING. *Lectures and Problems.* (Dickerson)

A study of the principles of design for heating and ventilating private and public buildings. An example is used for illustrating the various systems of furnace heating, hot water and steam and comparisons made. The central heating system is also studied.

Prerequisite: Mechanical Engineering 9w.

Required in V.

Senior year, second term, three recitations, three hours' laboratory and six hours' preparation per week.

Text: Hoffman, *Handbook for Heating and Ventilating Engineers.*

18w. MACHINE SHOP. *Laboratory.* (Bowen)

This course begins with chipping to a line, filing to a dimension, and scraping to a surface plate. Machine operation is then begun; the principles and uses of the drill-press, lathe, planer, shaper, and milling machines are taught by lectures followed by

practical work at each machine. After a reasonable time, skill is attained in operating the various machines through a course of graded exercises. In this work use is made of the vernier, micrometer, thread-micrometer, and gear-tooth caliper. Entire machines are also built, such as lathes, gasoline engines, wood trimmers. The degree of accuracy thus acquired enables the student to use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

Prerequisite: Mechanical Engineering 14f.

First or second term, six hours per week.

19w. INDUSTRIAL ENGINEERING. *Lectures.* (Bowen)

This course comprises lectures on the construction and the arrangement of buildings for manufacturing plants; the heating and lighting of such buildings; the installation and arrangement of machinery in them and also the maintenance of plants is considered. Shop management is especially studied during the course.

Prerequisite: Mechanical Engineering 9f.

Required in V.

Senior year, second term, two recitations and four hours' preparation per week.

20f. MACHINE DESIGN. *Laboratory.* (Dickerson)

The individual shapes and strength of the working parts of machines are studied, keeping in mind the frame upon which these parts are to be assembled. Such problems as the design of bearings, clutches, hooks, pulleys and also machine tools as found in machine shops.

Prerequisites: Mechanical Engineering, 3f, 4f, and 18w.

Required in V.

Junior year, first term, six hours per week.

Text: Halsey, *Handbook for Machine Designers.*

20w. ENGINE DESIGN. *Laboratory.* (Dickerson)

In this course the student completely designs a steam or gas engine, making comparisons with "Manufacturers' Averages." The report includes the calculation and detailed drawings.

Prerequisite: Mechanical Engineering 20f.

Required in V.

Senior year, second term, six hours per week.

Text: Halsey, *Handbook for Machine Designers.*

22f. MACHINE DESIGN. *Laboratory.* (Dickerson)

This course takes up the design of the shapes and strength of the working parts of machines similar to that in 20f.

Prerequisites: Mechanical Engineering 3f, 4f, and 18w.

Required in VI.

Junior year, first term, three hours per week.

24f. POWER PLANT DESIGN. *Laboratory.* (Dickerson)

The student makes preliminary surveys, and from this, with what further data needed, designs a complete power plant. The generation and sale of the power as well as the by-products, such as steam for heating, are taken into account. Drawings for proposed plants are made and plans for reconstruction are worked up. Maintenance, stand-by losses, insurance and depreciation are considered in the selection of the machinery.

Prerequisite: Mechanical Engineering 9f.

Required in VI.

Senior year, first term, six hours per week.

ASSAY LABORATORY.

METALLURGY AND ORE DRESSING BUILDING.

METALLURGY AND ORE DRESSING

Associate Professor Clayton, Acting Assistant Professor Thornberry, Mr. Potts, Mr. Leach.

Equipment.

The assay laboratory has a floor space of forty-eight hundred square feet. In the main room are twenty coal-fired, double-muffle assay furnaces, twelve gasoline-fired muffle furnaces, and ten coke-fired furnaces. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces.

A room 16 by 16 feet, separated from the furnace laboratory by glass partitions, is used for parting. There are in this room the necessary hot plates, acid jars, and annealing muffles. The desks in this laboratory are topped with white tiling.

The balance room is 20 by 20 feet and is lighted only from the north. It is easily kept at constant temperature. There are twenty-four balances suitable for weighing gold. A number of these balances have the multiple-rider attachment.

For chemical work in connection with metallurgy there is a well-lighted room having fifty-six lockers and fifty-six desks. Each desk is provided with gas, compressed air, and water. There is in the room ample hood space; in fact, the laboratory has everything necessary for general chemical work.

There is, in main furnace room, a circular water-jacket blast furnace 20 inches in diameter at the tuyeres and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster, and an experimental zinc distilling furnace.

A stock room, containing chemicals, clay goods, glassware, and other supplies, serves all the laboratories. The ore-sample room is especially well equipped. It contains more than 1,000 samples of ore of varied classes. Each sample is stored away in paper sacks, all ready for issuing to the students. Each sample has been prepared and carefully assayed. Enough of each lot of ore has been prepared to give 200 to 300 samples of the same lot. The sample room, therefore, contains more than 1,000 different samples of ore, each sample being divided into 200 or more smaller samples, each of the smaller samples being ready for immediate issue.

Throughout the metallurgical and ore dressing laboratories care has been taken that each furnace, each piece of apparatus, should be so arranged as to be fitted best for that testing work which must be so great a part of the student's work. In all the laboratory work, in addition to demonstrating the theories and principles explained in the classroom, the attempt is made to give the man ability to do a day's work and to teach him to use both his head and his hands.

The main floor of the ore dressing laboratory occupies a space of forty-eight hundred square feet and a mezzanine floor provides an additional space of thirteen hundred square feet. The equipment of the laboratory is as follows: The crushing and sampling department contains a gyratory breaker, a Dodge breaker, a pair of 9-inch by 12-in. rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests are provided a three-stamp mill, with amalgamated plates and a 3½-foot Huntington mill.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a duplex Callow traveling belt screen, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely-crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, one Deister-Overstrom table, and a laboratory James table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected, motor-driven centrifugal sand pumps are used for elevating finely-crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a small gyratory breaker, a disc grinder, a coffee mill, a pair of rolls, a number of bucking boards and mullers, a laboratory tube mill, a Ro Tap testing sieve shaker and an electric sample dryer.

The cyanide unit contains a laboratory leaching plant with all necessary tanks, a 16-in. Hendryx clay agitator, a 14-in. Hendryx combination agitator and filter, and a six-leaf 12-in. by 12-in. filter press.

Ores suited to a magnetic concentration are treated on a Knowles magnetic separator, and for the preparation of such ores a cylindrical dryer and roaster, together with a plane impact screen for dry sizing, is provided.

For testing ores by flotation, the laboratory is equipped with machines that represent the latest thing in the way of oil flotation.

There are eight machines of the mineral separation type, four of which are of the modified air-life type, one Janney machine (the gift of D. C. Jackling), and one Callow machine. Each machine is arranged so that it can be run independent of all others or in combination.

The laboratory, which is lighted by two "daylight" nitrogen lamps, is well equipped with hot plates, drying areas, water and air pipes, and other equipment that goes toward facilitating work.

We have on hand about one hundred and fifty oils, most of which have been carefully classified according to their merits as flotation oils. Besides the oils, we have a large number of re-agents that are used as addition agents in the flotation process.

Throughout the mill, wherever possible, the practice of driving each machine with an individual motor has been followed.

The pyrometry laboratory is well equipped with various types of instruments suitable for measuring temperatures up to 3,500 degrees F. Two Leeds and Northrup recording potentiometers, one indicating potentiometer, one Wilson-Maulin tapalog, and several millivoltmeters, constitute the instruments suitable for measuring temperatures up to 2,700 degrees F. Both base metal and noble metal couple with compensating leads can be used interchangeably on the double-range instruments.

A Warner optical pyrometer and a Leeds and Northrup optical pyrometer will measure the highest attainable temperature.

Electric furnaces capable of attaining temperatures up to 3,600 degrees F. are used for melting metals for standardizing the various pyrometers.

Metallography Laboratory equipped with horizontal polishing machines, Bausch and Lomb metallurgical microscopes and one inverted microscope furnishes ample facilities for a complete study of metals and their alloys. Some 500 specimens form an interesting collection for showing the effect of mechanical and thermal treatment on ferrous and non-ferrous alloys.

It is recognized that the school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim to give such training in the fundamental principles and their application that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

1. FIRE ASSAYING. *Lectures.* (Potts)

This course deals with the theory of fire assaying as practiced in the laboratory. The points discussed a reoutlined under Metallurgy 2w.

Prerequisites: Chemistry 1f and 2f.

Required in II. and VII.
Junior year, first term, two lectures, one hour preparation.
Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

2. FIRE ASSAYING. *Laboratory.*
(Clayton, Thornberry, Potts, Leach)

This work includes the assay, by scorification and crucible methods of ores from the various districts of the United States. Copper ores, copper mattes, and copper bullion are assayed by fire and by the combination method. Lead ores and furnace products are assayed for lead and for gold and silver. Assays of cyanide, solutions, of zinc-box residues, of silver bullion, of gold bullion, of lead bullion, and of silver-mill precipitate, are included in this course. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying, the student studies the losses occurring. He learns the effects of different schemes of firing the furnaces by making analysis of the flue gases and by pyrometric measurements. The laboratory is so arranged that even with large classes a student is not hampered by other students and he learns to handle a large amount of work with the best utilization of his time.

Prerequisites: Chemistry 1f and 2f. To be preceded by Geology and Mineralogy 1f.
Junior year, second term, nine hours per week.
Texts: Lodge, *Notes on Assaying.*
Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*

4. FIRE ASSAYING. *Laboratory.*

This course covers the work outlined in Metallurgy 2 briefly.
Prerequisites: Chemistry 1f and 2f. To be preceded or accompanied by Geology and Mineralogy 1f.
Elective.
Junior year, first term, six hours per week.

6. FIRE ASSAYING. *Laboratory.*

This course attempts to briefly cover some of the more important operations as outlined in Metallurgy 2.
Prerequisites: Chemistry 1a and 2f.
Required in VII.
Junior year, second term, three hours per week.

7w. GENERAL METALLURGY. *Lectures and Laboratory.* (Clayton)

This course is an introduction for the advanced metallurgical courses. The work is covered in a general way by the following headings: The properties of metals; the chemical equation from the standpoint of the metallurgist; methods of combustion; the temperature of combustion in any system and the effect thereon of certain variables; measurement of high temperatures; means of supplying oxygen for combustion, including stack design; metallurgical fuels and methods of firing, including a study of coals, coke, charcoal, gases from producers, and liquid fuels; calorimetry; refractories and their uses; types of furnaces and the reasoning involved in their design; a general study of typical metallurgical operations, including pyrometallurgical, hydrometallugrical and electrometallurgical processes; slags in general; conduction, radiation, and convection from the standpoint of the metallurgist. In this course much attention is given to the methods of attaching various metallurgical problems.

Prerequisites: Chemistry 3w and 4w, Geology and Mineralogy 1w.

Required in I. and II.

Junior year, second term, three recitations, three hours' laboratory and three hours' preparation.

Texts: Fulton, *Principles of Metallurgy.*
Hofman, *General Metallurgy.*
Richards, *Metallurgical Calculations.*
Burgess and Le Chatelier, *The Measurement of High Temperature.*

9w. METALLURGY OF IRON AND STEEL. *Lectures.* (Clayton)

This course is intended for those intending to follow metallurgy. It takes up in detail the study of iron and steel and the work follows these general headings: The properties of iron and its alloys and compounds; specifications for standard irons and steels; the ores of iron and the principles underlying their valuation; the preparation of iron ores for the blast-furnace; the iron blast-furnace, its construction and operation; the manufacture of pig-iron; the properties of pig-iron, and the factors upon which these properties depend; the calculation of furnace charges; the chemistry of the blast-furnace; the metallurgical operation of the blast-furnace; blowing engines; utilization of furnace gases; treatment of flue dust; heat balance of the operation of a blast-furnace; the manufacture of steels by the basic and acid bessemer, basic and acid open-hearth crucible, and electric furnace methods; the manufacture of wrought iron; the constitution and structure of

iron and steel; heat and mechanical treatment of steel; foundry practice; uses of steel products; and the study of special steels.

Prerequisites: General Metallurgy, to be accompanied by 7w.

Required in II.

Junior year, second term, three hours' recitation, three hours' preparation.

Texts: Stoughton, *Metallurgy of Iron and Steel.*
Sauveur, *Metallography of Iron and Steel.*
Carnegie, *Liquid Steel.*
Howe, *Metallography of Cast Iron and Steel.*
Richards, *Metallurgical Calculations, Vol. II.*

11f. METALLURGY OF THE NON-FERROUS METALS.
Lectures (Clayton)

This course includes a study of the metallurgy of lead, copper, zinc, gold, silver, tin, antimony, and aluminum. The greater part of the time is spent on the metallurgy of lead, copper, zinc, gold, and silver.

METALLURGY OF LEAD. The course in the metallurgy of lead includes work along the following general lines: The properties and uses of lead, its alloys, and compounds. The ores of lead and methods and principles of their sale. Principles and practice of sampling ores and products. The general principles made use of in the winning of lead from its ores. The treatment of lead ores in the reverberatory smelting furnace. The winning of lead from its ores by smelting in the ore hearth or Scotch hearth, considerable attention being paid to this method on account of its importance with the ores of the Mississippi Valley. The roasting of lead ores and the strides that have recently been made in this important preliminary to the lead blast-furnace. The winning of ores in the lead blast-furnace. This heading is, of course, an important one in the subject, and under it are taken up the blast-furnace plant, the chemistry of the blast-furnace, the calculation of furnace charges, the calculation of costs of smelting, the handling of products, particularly the smoke or fume. The desilveration of base bullion, as well as by the Betts process. Throughout this course, as well as the other courses in this department, the work is accompanied by problems which bring out the ideas that classroom work considers.

Texts: Hofman, *Metallurgy of Lead.*
Collins, *Metallurgy of Lead.*
The Articles Appearing in the Technical Journals.

METALLURGY OF COPPER. The metallurgy of copper is considered along the following general lines: The properties and uses of copper, its compounds, and its alloys. The markets for copper

and its ores and principles underlying their sale and price. The ores of copper. The smelting of roasted and oxidized ores of copper to black copper is touched only briefly. The roasting of copper ore as a preliminary to blast-furnace and reverberatory smelting. The handling of the smoke from copper furnaces to save the values contained therein and to remove from these gases their injurious constituents. The smelting of roasted ores to matte in the reverberatory furnace. The smelting of roasted ores to matte in the blast-furnace either with or without the attempt to volatilize a considerable portion of the sulphur. The smelting of raw massive sulphides to matte in the blast-furnace, or pyrite smelting. The converting of copper matte to blister copper in the basic and in the acid converter. The furnace refining of copper. The production of copper from matte by the various roast-reaction of roast smelting methods. The electrolytic of copper.

Texts: Peters, *Practice of Copper Smelting.*
Peters, *Principles of Copper Smelting.*
Hofman, *Metallurgy of Copper.*
References in the Technical Journals.

Metallurgy of Zinc. The metallurgy of zinc is considered under the following headings: The properties and uses of zinc, its alloys, and its compounds. The ores of zinc and the methods and principles underlying their sale. The roasting of zinc ores, with a brief study of the use of zinc ores as a source of sulphuric acid. The distillation of zinc ores and the furnaces suited for this purpose. The factors on which the success of the distillation depends. The manufacture of retorts and condensors. The laws of condensation of vapor to liquid and their application to the condensation of zincs vapors. The product of zinc smelting, and the methods of handling and treating these products. The cost of smelting zinc ores figured on the basis of a number of typical ores. The refining of spelter. The markets for spelter and the various brands of spelter. Special schemes other than the ordinary methods that have been used or proposed for use in the winning of zinc from its ores. The manufacture of zinc oxide pigment. Throughout the course problems are given to illustrate the ideas set forth in the class.

Text: Ingalls, *Zinc.*

Metallurgy of Gold and Silver. The metallurgy of gold. The work of this course includes lectures and recitations along the following general lines: The properties of gold, gold alloys, and the compounds of gold. The winning of gold from placer ground by dredging and hydraulicking, including methods of investigating the value of placers. The chlorination and bromination of gold ores are considered more in the light of the historic value of these processes than for their present importance as schemes of gold

extraction. The amalgamation methods for silver and gold ores are taken up in detail in the course on ore dressing.

The metallurgy of silver is considered as suggested by the following headings: The properties of silver, of its alloys, and of the compounds of silver. The winning of silver from its ores by the various leaching schemes that were formerly of greater importance than at present. These schemes include the Augustin process, the Ziervogel or Argo process, the various methods of hyposulphite leaching; they are considered only briefly. The greater part of the time of the course in gold and silver is devoted to the study of the cyanide process, which is considered in considerable detail. The parting of gold and silver by the various acid and electrolytic schemes. The winning of gold and silver from their ores by the various smelting schemes is considered under the head of metallurgy of lead and copper.

Texts: Rose, *Metallurgy of Gold.*
Collins, *Metallurgy of Silver.*
Julian and Smart, *Cyaniding.*
Clennell, *Cyaniding.*
The Technical Journals.

Prerequisite: Metallurgy 7w.
Required in II.
Senior year, first term, three lectures, one recitation and three hours' preparation.

12f. METALLURGY. *Laboratory.*

This course covers the testing of ores for process treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixivation, concentration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods worked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect that freight rates and such other factors have on the treatment which an ore should receive. Experiments are made in the reverberatory and the "pot" roasting of ores, and on blast-furnace smelting of ores. Furnace heat equations are made by each student from data collected by himself.
Prerequisite: To accompany Metallurgy 11f.
Senior year, first term, three hours.

11w. METALLURGY OF THE NON-FERROUS METALS.
Lectures. (Clayton)

This is a continuation of Metallurgy 11f.

Prerequisite: Metallurgy 7w.

Senior year, second term, three lectures, one hour's recitation and three hours' preparation.

Students working for a degree in either mining or metallurgy who take this course are required to take the metallurgy portion of the Senior Trip. All other students taking this course must either take the metallurgy portion of the Senior Trip or do equivalent work in metallurgy at Rolla.

12w. METALLURGY LABORATORY.

This is a continuation of Metallurgy 12f.

Prerequisite: Metallurgy 12f.

Senior year, second term, three hours per week.

13f. METALLURGY PROBLEMS. (Clayton)

These problems aim to cover the common ones that the metallurgist meets in practice.

Prerequisite: Metallurgy 7w. To accompany Metallurgy 11f.

Senior year, first term, three hours' recitation, three hours' preparation.

Text: Richards, *Metallurgical Calculations.*

17w. ELECTRO-METALLURGY. *Lectures.* (Clayton)

Lectures are given covering the electro-metallurgical processes that are in use. Efficiency and engineering calculations based on these processes are given.

Prerequisites: Metallurgy 7w, Physics 1w and 3f, Chemistry 9f, 10f and 7f.

Senior year, second term, three hours' recitation, three hours' preparation.

18w. ELECTRO-METALLURGY. *Laboratory.* (Clayton)

This course gives a study of the principles of electro-metallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed and calculations as to efficiency are made on electric smelting.

Prerequisites: Physics 1w and 3f, Chemistry 9f, 10f and 7f, accompanied by Metallurgy 17w.

Senior year, second term, six hours per week.

19w. ADVANCED ELECTRO-METALLURGY. *Laboratory.* (Clayton)

This course is a continuation of Metallurgy 18w.

Prerequisites: Physics 1w and 3f, Chemistry 9f, 10f and 7f, Metallurgy 17w, 18w.

Senior year, second term, three hours per week.

21f. ORE DRESSING. *Lectures.* (Thornberry)

In this course the principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances. The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

Senior year, first term, three hours' recitation, three hours' preparation.

Text: Richards, *Textbook of Ore Dressing.*

22f. ORE DRESSING LABORATORY. (Thornberry, Potts)

The student becomes familiar with the operation and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

Prerequisite: Must accompany Metallurgy 21f.

Senior year, second term, three hours per week.

21w. ORE DRESSING. *Lectures.* (Thornberry)

This course is a continuation of Metallurgy 21f.

Prerequisites: Metallurgy 21f, 22f.

Senior year, second term, three hours' recitation, three hours' preparation.

Text: Richards, *Textbook of Ore Dressing.*

Students in mining or metallurgy taking this course are required to take the ore dressing of the Senior Trip. All other students are required to take the trip or do equivalent work in ore dressing at Rolla.

22w. ORE DRESSING LABORATORY. (Thornberry, Potts)

This course is a continuation of Metallurgy 22f.

Prerequisite: Must accompany 21w.

Senior year, second term, three hours a week.

26f. ORE DRESSING PROBLEMS. *Laboratory.*
(Thornberry)

This covers a portion of the work given in Metallurgy 34b. It is intended for students wishing to spend a limited amount of time in mill designing.

Prerequisites: Metallurgy 21f, 22f; Shop Practice and Drawing 2w. To be accompanied by Metallurgy 21f, 22f.

Senior year, first term, six hours per week.

26w. ORE DRESSING PROBLEMS. *Laboratory.*
(Thornberry)

In this course advanced work is given in connection with the design of plants and machinery for the treatment of ores. The course includes the determination of a practical process for treating a given ore, and the design for a mill for utilizing this process.

Prerequisites: Metallurgy 21f, 22f, 26f; Shop Practice and Drawing 2w. To be accompanied by Metallurgy 21w, 22w.

Senior year, second term, three hours per week.

31f. ALLOYS AND METALLOGRAPHY. *Lectures.*
(Clayton)

These lectures deal with the theoretical and practical consideration that influence the structure and properties of alloys of different types.

Prerequisites: Chemistry 7f, Metallurgy 7w.

Senior year, first term, three hours' recitation, three hours' preparation.

32f. ALLOYS AND METALLOGRAPHY. *Laboratory.*
(Clayton)

This laboratory course is given in connection with the lectures, and deals chiefly with the micro-structure of iron and steel.

Prerequisites: Chemistry 7f, Metallurgy 7w. Must accompany 31f.

Senior year, first term, three hours per week.

35w. ALLOYS AND METALLOGRAPHY. *Lectures.*
(Clayton)

This course is a continuation of Metallurgy 31f.

Prerequisites: Metallurgy 31f, 32f.

Senior year, second term, two recitations, four hours' preparation.

36w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This course is intended for those who wish to devote more time to the study of the structure of alloys than is possible with 32f.

Prerequisites: Chemistry 7f, Metallurgy 31f, 32f.

Senior year, second term, six hours per week.

38w. ALLOYS AND METALLOGRAPHY. *Laboratory.* (Clayton)

This course is intended for men wishing to specialize in iron and steel.

Prerequisites: Chemistry 7f, Metallurgy 9w, 31f, 32f.

Senior year, second term, nine hours per week.

41w. METALLURGICAL MEMOIRS. *Lectures.* (Clayton)

The student in the Metallurgy curriculum is required to do considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by each student.

Prerequisite: Metallurgy 11f.

Senior year, second term, one hour's recitation, three hours' preparation.

43w. METALLURGY PLANT. *Lectures.* (Clayton)

The arrangement of various metallurgical works are studied. The advantages and disadvantages of different equipments are given.

Prerequisites: Metallurgy 7w, 11f, 11w.

Graduate course, first term, one lecture, one hour's recitation, three hours' preparation.

44w. METALLURGY PLANT DESIGN. *Laboratory.* (Clayton)

This is a drafting-room course and the student is given problems to solve in detail, covering a part of the classroom discussions. Each student is required to submit complete drawings, specifications and estimates of cost.

Prerequisites: Shop Practice and Drawing 2w, Metallurgy 7w, 11f, 11w.

Graduate course, first term, six hours per week.

45w. CYANIDING. *Lectures.* (Clayton)

This course teaches the principles and practice of cyaniding. The student keeps up with the progress in the art. Attention is given in all the work to the cost of operation and to the schemes used and proposed for lessening the cost. A detailed study is made of the types of filter presses, crushing machinery and other devices used in cyanide mills. Cyaniding is compared with other possible methods of treatment.

Prerequisites: Metallurgy 1f, 2 and 7w.

Graduate course, second term, two lectures, two recitations and two hours' preparation.

46w. CYANIDING. *Laboratory.* (Clayton)

The student in this course has an opportunity to test in the laboratory the methods discussed in the classroom. The work is not routine, but the experiments are arranged to bring out a point under discussion, or to solve, if possible, the problems occurring at the time in the classroom.

Prerequisites: Metallurgy 1f, 2 and 7w. To accompany Metallurgy 45w.

Graduate course, second term, six hours per week.

ORE SUPPLY. *Lectures.* (Clayton)

This course is intended to bring out the important subject of ore, flux, and fuel supplies. The subject is studied from a combined commercial and technical standpoint. The problems of valuing fluxes and fuels, of mixing ore so that the mixture shall command the lowest treatment rate, and of preparing, from the reduction works' standpoint, treatment charges for different classes of ores, are studied.

Prerequisites: Metallurgy 11f, 11w.

Graduate course, second term, two lectures, two hours' preparation.

47f, 48f. METALLURGICAL RESEARCH. *Laboratory, Reading and Conferences.* (Clayton)

Each graduate student elects a subject for special study. It is recommended that the work be along a different line from the subject chosen for thesis. The course consists principally of assigned reading, together with conferences with the professor on matter read. The laboratories are always open for the solving of any problem that may arise.

Prerequisites: Metallurgy 11f, 11w.

Graduate course, first term, two relations, six hours' preparation, six hours' laboratory.

49w. METALLURGICAL RESEARCH. *Laboratory, Reading and Conferences.* (Clayton.)

This course is a continuation of Metallurgy 47-48.

Prerequisite: Metallurgy 47.

Graduate course, second term, two relations, eight hours' preparations.

50w. ADVANCED METALLURGICAL PROBLEMS. *Lectures.* (Clayton)

This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions.

Prerequisite: 13f.

Second term, one hour's recitation, two hours' preparation.

MILITARY SCIENCE AND TACTICS

Major Wild, Master Engineer Scott.

The War Department maintains an Engineer Unit, Senior Division of the Reserve Officers' Training Corps at the School of Mines.

Summer Camps.—Two summer camps will normally be held—a basic camp and an advanced camp. The basic camp may be attended or not, as the student may elect, and if elected, may be attended at the end of the first or second year of the basic course or at the end of both years. One advanced camp is compulsory for students who enter the advanced course and it will be taken at the end of the first year of that course except in those cases where the institution enters into a special arrangement with the War Department to permit students to attend camp at the end of the second year. The perior of instruction at camps will be properly divided between training in the fundamental military subjects and training in the special technical subjects in the arm or service concerned.

Transportation, Camp Allowances, Etc.—Transportation, subsistence, uniforms, equipment, and medical attendance will be furnished members of the R. O. T. C. attending summer camps.

Election of Courses.—Students electing R. O. T. C. work do so for only two years at a time. The first election is for the two years' basic course, after which, if the student is recommended for further training, he may elect the advanced course for the remainder of the college course. During this time he will receive commutation of rations amounting to about $12.00 a month.

Military Science and Tactics is required of all physically fit Freshmen and Sophomores and may be elected by Juniors and Seniors. If a student joins the R. O. T. C., the War Department will furnish his uniform and equipment. If he does not join the R. O. T. C., he must buy his own uniform.

If the student elects to take more than two years in the R. O. T. C., he will take Military Science and Tactics listed as elective in the Junior and Senior years and some engineerings subjects of military value approved by the Professor of Military Science and Tactics for his full R. O. T. C. credit.

The Cadet Corps is organized as a battalion of two or more companies, and the cadet officers are selected, as far as possible,

from the members of the two upper classes who have elected to take the advanced course.

The course as outlined has for its primary object the training of students in Engineering, so that, at the termination of their instruction, they will possess the following essential characteristics of a well-balanced junior officer of Engineers: (a) a good general education; (b) a good engineering education; (c) a well-disciplined mind and body; (d) the basic training in Military Art. The first two characteristics are covered by the general courses in the college. The attainment of the third characteristic will be reached by the combination of training on the drill ground, lecture room, gymnasium, and summer camps. The fourth is covered by the purely military training, which is divided into two periods, the first being covered by the Freshman and Sophomore classes and taking three hours a week, the second by the two upper classes and taking five hours a week.

In the military department the different subjects interlock and are arranged in accordance with the weather conditions and therefore the two terms are not segregated.

MILITARY 1f, 1w.;

Organization, military courtesy and discipline; Drill, close and extended order; Ceremonies, road marches, care and handling of arms and equipment, small arms firing, personal hygiene, first aid and sanitation, interior guard duty, minor tactics, morale.

Weekly: One hour lecture, one hour recitation, one hour drill, one hour preparation, required in 1., II., III., IV., V., VI., VII.

MILITARY 2f, 2w.;

Organization, military courtesy and discipline; Drill, close and extended order; Ceremonies, road marches, care and handling of arms and equipment, small arms firing, personal hygiene, first aid and sanitation, interior guard duty, minor tactics, morale, liaison, signaling, topography and map reading, organization and staff relations, engineer troops, military bridges, and river crossings, fortifications, road and communications.

Weekly: One hour lecture, one hour recitation, one hour drill, one hour preparation, required in I, II., III., IV., V., VI., VII.

MILITARY 3f, 3w.;

Camp sanitation and care of troops in the field, minor tactics, liaison, topography and military mapping, field engineering, military law, Military policy, light railways, explosives, demolition and mine warfare, fortifications, duties as cadet officers and instructors.

Elective: Junior year.

R. O. T. C.

CAMPUS VIEW.

MILITARY 4f, 4w.;

Minor tactics, topography and military map making, company administration, military policy and history, military law, hippology, functions and staff relations of engineers, map problems, involving engineer problems, organization and administration of engineering projects, thesis on military engineering subject, duties as cadet officers and instructors.

Elective: Senior year.

Junior and Senior years, first and second terms, one lecture, one recitation, one hour's drill, one hour's preparation and six hours on some engineering subject of military value, per week.

MINING

Professor Forbes, Mr. Uthoff.

The mining lecture room, located on the first floor of Norwood Hall in the southwest corner of the building, is provided with a combination lantern, reflectoscope and moving-picture machine. The school has several hundred lantern slides of mining scenes and mining machinery, and motion films showing mining operations are obtained from the U. S. Bureau of Mines. Three rock drills in section, supported on a suitable frame, are kept in the classroom, together with exhibits of explosives, rock-drill bits, wire ropes, safety lamps, mine-rescue apparatus and various other mining appliances.

A number of models illustrating mining methods, head frames, mine timbering, skip dumps, reversible mine fan, methods of locating drill holes in tunneling and rotary drill for coal mining, are on display in the mining laboratory and are used in connection with the lecture work.

The surveying equipment, already referred to under Civil Engineering, includes a number of mining transits with auxiliary telescopes which are used for the field work in mine surveying.

Laboratories.

To meet the needs of some of the more important phases of mining work four laboratories have been equipped as follows:

Mine-Rescue and First-Aid Laboratory.

In accordance with the safety-first movement that has been making such rapid strides in the last few years, it has been deemed advisable to establish a mine-rescue and first-aid laboratory, where instruction is given in the use of breathing apparatus and in first aid to the injured. The equipment consists of three helmets, including a Draeger, Fleuss and Westfalia, a pulmotor, and all necessary first-aid supplies and charts. The time devoted to this laboratory does not exceed one afternoon a week for six weeks, but this is sufficient to familiarize the student with mine-rescue apparatus and to give him a fair knowledge of the principles of first aid.

In the fall of 1919, the Mine-rescue and First-aid work was given by the U. S. Bureau of Mines, from one of their mine-rescue cars, which was in Rolla for a period of two weeks.

Rock-Drilling Laboratory.

On account of the importance of rock drilling in metal mining operations, and also because it can readily be carried on in the laboratory, much stress is laid on this branch of the work, for which the following equipment is used: Piston drills; Ingersoll-Rand 2¼-inch auxiliary-arc-tappet drill; Ingersoll-Rand C-110 Butterfly; Sullivan 2¾-inch tappet; Sullivan 2¼-inch differential valve, with steam and air-front heads; Sullivan FF-12 with water attachments; Wood 2¼-inch spool-valve. Hammer drills: No. 7 Water Leyner. Stopers: Waugh 16-V; Sullivan DA-21, with reverse feed. Hand hammer drills: Ingersoll-Rand jack-hammer; Hardsocg; Cleveland; Ft. Wayne electric drill.

This equipment has been purchased from time to time as improvements have been made by the manufacturers, and although not complete, embraces most of the different types of air drills in use at present.

For the work of drilling, large blocks of red granite about 4x4x5 feet are imported from Southeast Missouri. Two drilling frames for supporting the machines on columns and arm have been constructed—one under cover in a frame building, and the other out of doors.

For sharpening steel, besides the usual hand tools, there is a Leyner-Ingersoll 5-A sharpener with a complete assortment of dies and dollies for forming various-shaped bits, including the cross, X, Z, bull, five-point, six-point, eight-point, high-center and single and double-chisel bits, as well as parts for shanking Leyner, Jack-hammer and piston steels.

The work done in this laboratory consists in sharpening steel both by hand and with the sharpener, and in drilling with the various machines. No attempt is made to drill a great number of holes, but the work consists in measuring cutting speeds with different bits and air pressures, noting variations in length and number of strokes under varying conditions and measuring air consumption. For this purpose a Sullivan air meter is used, and an electrical device designed at the school is used for counting the number of blows of the drill.

The amount of time spent in the laboratory does not exceed three hours a week or one laboratory period for one semester in the regular course, but much use is made of it in thesis and experimental work.

Compressed-Air Laboratory.

The use of compressed air is so important in mining operations that the school has deemed it advisable to equip this laboratory with apparatus that would be suitable not only for students' use, but also for purposes of research and investigation.

A Sullivan WB-2 straight-line air compressor of 290 cubic feet capacity supplies air for this laboratory as well as the rock-drilling laboratory, and a Laidlow-Dunn-Gordon compressor, used by the school in pumping from a deep well, is in the same building and furnishes a different type for study.

Two large displacement tanks 15 feet high and 5 feet in diameter are used for making accurate measurements of air for the determination of orifice coefficients and various other experiments. Another interesting installation in this laboratory is a mine fan. This is a 36-inch single-inlet "Sirocco," directly connected to a 35-h. p. variable-speed motor, and has a capacity of 20,000 cubic feet per minute against a 4-inch water gauge. Two styles of runners with vanes at different angles are provided for experimental work. The fan is used in the regular laboratory work, where its efficiency is determined under varying conditions, and also for experimental work in air measurements, and the standardization of large orifices.

Mine Plant

The mine plant is situated about one and one-half miles from the school, which was the nearest point available where rock of a suitable nature could be found. A tunnel is being driven into the hillside, as shown in the engraving. The rock is a pitted dolomite.

The power plant for running the machine drills used in the tunnel consists of a 50-h. p. fire-tube boiler and an Imperial type 10 Ingersoll-Rand air compressor of 100 cubic feet capacity. Water for the boiler is pumped from a nearby stream with a centrifugal pump driven by a 3-h. p. Ferro, two-stroke per cycle, gasoline engine. A 5x7 Davis and Rankin steam engine and a 3.6-kw., 110-volt United States dynamo furnishes electricity for lighting the plant and for operating an electric drill. This unit has an interesting historical value. In 1892 it furnished all the power for the shop and for the dynamo laboratory, which were then located in the basement of the Rolla building.

In designing the power plant, an endeavor was made to introduce as great a variety of machinery as possible, as the operation of the plant is considered one of the most valuable features of this work.

The total time spent in the mine-plant laboratory is about the same as in the rock-drilling laboratory, but instead of working the usual three-hour period, from nine to twelve hours are put in at a time, as a three-hour period is entirely too short for this kind of work.

The work is largely experimental, and consists in using different explosives and analyzing their products of combustion; trying out different methods of placing holes for blasting and different methods of setting off blasts; time studies of drill operations are

made, and cost-records of the work are required. In addition to this, the work of sharpening steel, timbering, mucking, track laying and hand drilling, together with the experience of running the power plant, affords a greater variety of work than can ordinarily be had in a reasonable length of time in practice. It is not the aim in this work to make drill runners or miners out of students, but to give them a greater familiarity with mining tools and methods than is obtainable from books or mere observation.

3f. MINING. *Lectures.* (Forbes)

A study of rock excavation, including rock drilling, explosives and blasting, supporting excavations, tunneling and shaft-sinking.

Prerequisites: Mechanical Drawing 2w, Physics 1w.

Required in I.

Junior year, first term, three lectures, one recitation and two hours' preparation per week.

Texts: Peele, *Mining Engineers' Handbook.*
Current Technical Journals.
Publications of U. S. Bureau of Mines.

4f. MINING LABORATORY. (Forbes, Uthoff)

Laboratory work in rock drilling and blasting, timbering, sharpening steel, track-laying, and operation of mine power plants. Reports are required on all work. A study of mine-rescue apparatus and first aid to the injured is included in this course.

No credit will be allowed in mining laboratory except in Curriculum I.

Prerequisite: Must be accompanied by Mining 3f.

Required in I.

Junior year, first term, three hours per week.

5w. MINE SURVEYING. *Lectures.* (Forbes)

The theory and practice of mine surveying are presented by lectures. The methods of carrying azimuth underground under different conditions are studied in detail, including shaft plumbing and the use of the auxiliary telescope. Notes of a completed mine survey are given the students, from which all calculations must be made and maps drawn. Other problems involving the strike and dip of veins are introduced, including the determination of intersection of veins, length of tunnels to interest veins at depth, and the determination of strike, dip and thickness of veins from bore-hole data.

Prerequisite: Civil Engineering 2.

Required in I.

Junior year, second term, three recitations and three hours' preparation per week.

Text: Durham, *Mine Surveying.*

6w. MINE SURVEYING. *Problems.* (Forbes, Uthoff)

One afternoon per week is devoted to the solution of problems in mine surveying and to making mine maps.

Prerequisite: Must be accompanied by Mining 5w.

Required in I.

Junior year, second term, three hours per week.

11w. MINING. *Lectures.* (Forbes)

This is a continuation of the work of the Junior year, and includes the study of mining methods, sampling and estimation of ores, mine valuation, and a study of mining costs. The principles of mining law are also reviewed.

Prerequisites: Mining 3f, Geology 9f.

Required in I.

Senior year, second term, three lectures, one recitation and three hours' preparation per week.

Students taking this course who do not take Course 12, will be given special work while the remainder of the class is taking the Senior Trip.

Texts: Hoover, *Principles of Mining.*
Finlay, *The Cost of Mining.*
Peele, *Mining Engineers' Handbook.*
Current Technical Journals.

12. SENIOR TRIP.

During the second semester of the Senior year, a two weeks' trip is taken to Joplin or to St. Louis, Flat River, and other points in the southeast Missouri lead district, for the purpose of studying mining, ore dressing, smelting, geology, and power plants of these districts. Several days are devoted to practical work in mine surveying, during which time a complete survey and map of some portion of a mine is made.

Required for graduation in Curriculum I.

13f. MINE VENTILATION. *Lectures.* (Forbes)

A study of the various gases met with in mines, their origin, effects and detection; the amount of fresh air required for men and animals under varying conditions; natural and artificial means of ventilation; gas and dust explosions, and mine-rescue work. A large part of the course is devoted to problems in mine ventilation.

Prerequisites: Mining 3f and Physics 3f.

Senior year, first term, three lectures, one recitation and three hours' preparation per week.

17w. MINING CONFERENCE. *Lectures.* (Forbes)

The conference consists in discussions relative to the mining laboratory work and lectures on mine accounting and bookkeeping. Reports are prepared by the student on various assigned subjects and presented to the class.

Prerequisite: Must be accompanied by Mining 16w.

Senior year, second term, one hour per week.

16w. MINING LABORATORY. (Forbes, Uthoff)

A continuation of the laboratory work of the Junior year. A feature of this work is the keeping of accounts and cost records of tunnel driving as a training in the study of mine accounting.

No credit will be allowed in mining laboratory except in Curriculum I.

Prerequisites: Mining 3f, 4f.

Senior year, second term, three hours per week.

19w. MINING ECONOMICS. *Lectures.* (Forbes)

Various economic problems of interest to mining engineers are studied. The influence of mining in the history of America and especially in United States history, is reviewed and the relation of mining to other industries is considered. The organization of the mining industry, the conservation of the mineral resources, and various problems in economics, including mining labor, wages, capital, taxation, profit-sharing, and employers' liability are presented by lectures and assigned reading.

Prerequisites: Mining 11w, Geology 9f.

Graduate course, first term, one lecture, three hours' preparation per week.

20f, 20w. MINE PLANT DESIGN. *Laboratory.* (Forbes)

This is a drafting-room course and is supplementary to all the previous mining courses. Each student is required to prepare complete drawings for the equipment of a given mine. Bills of material, specifications, and complete estimates are submitted.

Prerequisites: Mining 11w and Civil Engineering 15f.

Graduate course, first and second terms, six hours per week

23f. MINING LAW. *Lectures.* (Forbes)

A study of the mineral land laws of the United States and laws affecting the operation of mines, including workmen's compensation acts.

Prerequisites: Completion of the Junior year in Curriculum I.

Senior year, first term, one lecture and two hours' preparation.

38. JUNIOR TRIP.

At the end of the school year the members of the Junior Class may take a three weeks' trip to Colorado and Utah, or other mining districts. The purpose of the trip is to give an opportunity for the study of the geology, mining, and concentration of ores in the districts visited.

Credit may also be obtained for this trip in the following manner:

The student may obtain employment at any mine, mill, or smelter of his own selection, for a period of not less than six weeks. This work will be accepted as a substitute for the regular trip only when accompanied by a suitable report on the mining, metallurgy, and geology of the district in which he is employed. Outlines of these reports will be furnished by the various departments. Affidavits will be furnished the students, to be signed by the mine or mill officials by whom he was employed, stating the time of such employment and nature of work.

Required of candidates for degrees of B. S. in Mining or Metallurgy.

Prerequisites: Mining 5w, Geology 3w, and Metallurgy 39w.

PHYSICAL TRAINING

Associate Professor Dennie, Mr. Bruce, Mr. Murphy, Mr. Place.

For the physical training of students excellent opportunities are offered by the Jackling Gymnasium and the Jackling Field. The former, completed in 1915, at a cost of seventy thousand dollars, is a strictly modern fireproof building and is equipped with baths, dressing rooms, lockers, a swimming pool 20 feet wide and 60 feet long and various kinds of apparatus and game courts usually found in modern gymnasiums. Class work, consisting of setting-up exercises, developing exercises, calisthenics, the use of dumb-bells, clubs, and wands is given under the supervision of the Director of Physical Training. The aim of this work being to develop health, strength and vitality.

Jackling Field, constructed in 1909, by virtue of a gift of Mr. D. C. Jackling, '92, adjoins the Gymnasium and provides a football gridiron, a baseball diamond, and a quarter-mile running-track for class and intercollegiate games and events. A number of tennis courts about the campus are maintained in good order. Golf links near the campus are maintained for the benefit of the students.

The School encourages rational athletics and a participation in intra- and intercollegiate sport, all branches of which are under the direct supervision of the Director of Physical Training and management of the Board of Control. The membership of the Board of Control consists of the Director of Physical Training, the Chairman of the Faculty Committee on Athletics, the President of the Athletic Association, and the Secretary of the Executive Committee of the Board of Curators as ex officio treasurer.

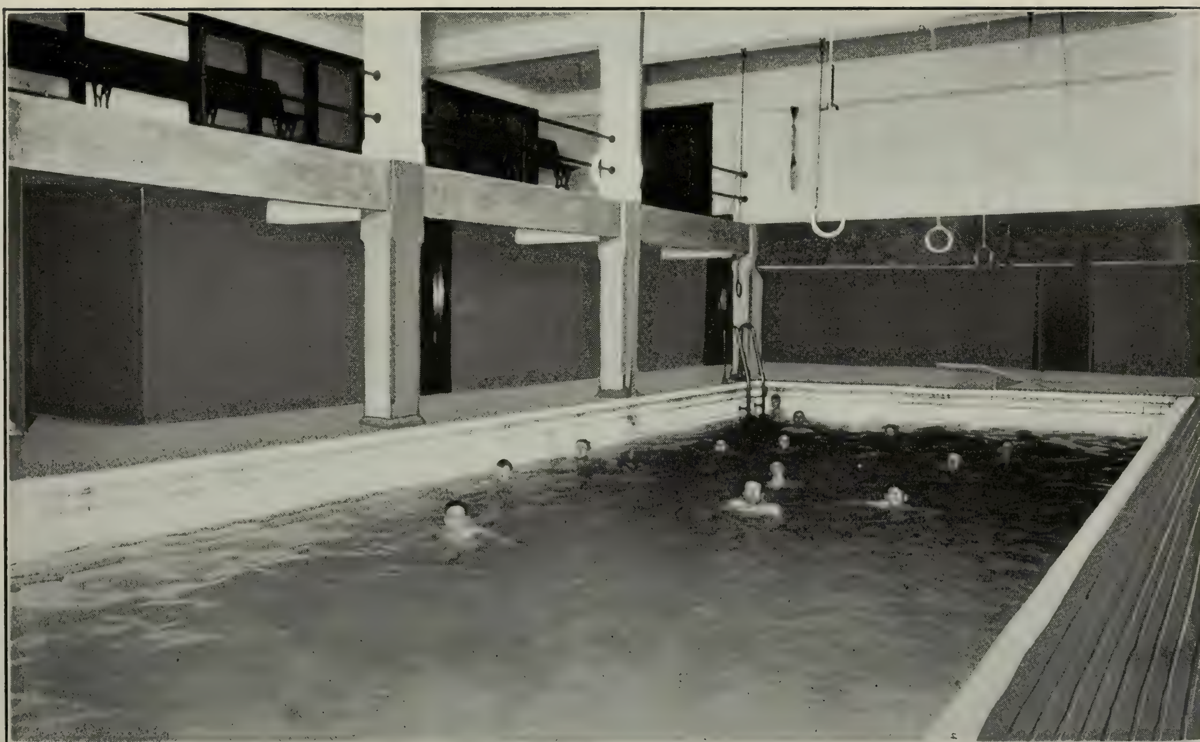
The personnel of the Board of Control for 1919-20: Mr. Dennie, Dr. Cox, Mr. Uthoff and Mr. Kahlbaum.

Physical exercise in military drill and gymnasium is required of all physically fit Freshmen and Sophomores. A student who is physically unfit for military drill may, upon the advice of the Director of Student Health, substitute special work in the Gymnasium for the regular exercises.

During the first term Freshman year, fifteen lectures in hygiene are given and one hour a week is devoted to setting-up exercises. During the second term, two hours a week are devoted to exercises with dumb-bells, chest weights and apparatus work.

During the Sophomore year two hours a week are devoted to exercises with wands, Indian clubs, chest weights, indoor games, and apparatus work.

GYMNASIUM.



SWIMMING POOL.

PHYSICS AND ELECTRICAL ENGINEERING

Professor Woodman, Assistant Professor Frame, Mr. Dorris.

Equipment.

The lecture room and laboratories for Physics and Electricity are in Norwood Hall. The lecture room will seat one hundred students and is provided with water, gas, and electric connections for conveniences in lecture demonstrations and experiments.

The physical laboratory is on the ground, or basement, floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound, heat, electricity, and light, and one equipped for the experimental work in electrical engineering. There is a constant-temperature room with double walls and air space insulation, a commodious dark-room with blackened walls for spectrometric and photometric measurements, a special laboratory for research work, and a shop for making and repairing apparatus.

The equipment includes a Rowland electro-dynamometer with shunts and resistances; a Leeds and Northrup standard potentiometer with shunts and voltage coils; a Leeds and Northrup decade Wheatstone bridge; a Queen postoffice pattern Wheatstone bridge; a Leeds and Northrup ohmmeter; various Wheatstone bridges and resistance boxes; standards of resistance and inductance; paper and mica condensers; various tangent, mirror, and ballistic galvanometers; a Duddell thermo-galvanometer; a Dolezalek quadrant electrometer; a Lummer-Brodhum photometer; a Bunsen photometer; a Gaetner dividing engine with linear and circular attachments; a Threlfall micro-manometer; a Dietzgen anemometer; a ten-inch induction coil; Crookes tubes; cathode and X-ray tubes; a Van Hooten and Tenbroeck electrostatic machine; a wireless demonstration set; a Gaetner electroscope for radio-active measurements; a Schmidt & Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; an Ives photograph of a Rowland grating; various balances; calorimeters; micrometers, calipers, together with apparatus for illustrating the principles of physics.

The dynamo laboratory contains an assortment of direct current generators and motors, a General Electric double-current

generator for direct-current and alternating-current work, a single and a three-phase generator, an induction motor, a single-phase repulsion motor, a rotary converter, stationary transformers, three-phase to two-phase transformers, Cooper-Hewitt mercury converters, a General Electric electrolytic motor-generator set, a remote control starting box, testing instruments, which include a Weston laboratory standard voltmeter with multipliers; a Weston laboratory standard millivoltmeter with shunts; Kelvin electrostatic stationary and portable voltmeters; Weston portable ammeters and voltmeters; Weston portable millivoltmeters with shunts, and mill-ammeters with resistances; Weston, Thomson, and Westinghouse portable direct-current and alternating-current voltmeters; Weston and Thomson portable wattmeters; Westinghouse portable polyphase wattmeter; Westinghouse portable single and polyphase watt-hour meters; Westinghouse portable voltmeters and ammeters with transformers; General Electric edgewise type alternating-current voltmeters, ammeters and watt-hour meters, electrodynamometers; Grassot fluxmeter; portable resistance grids, inductance coils, and condensers.

The various electrical motors used for power purposes in the shops and laboratories are available for testing in addition to the machinery in the dynamo laboratory. The total electrical equipment includes thirty-five motors, varying in size from ½ h. p. to 35 h. p., with the aggregate rating of 225 h. p.

Courses.

1f. GENERAL PHYSICS. (Woodman, Frame)

This course includes the study of kinematics, statics, kinetics, the mechanics of fluids, and heat, including an introduction to thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of such subjects as sound, light, and alternating currents of electricity. Lectures, illustrated by experiments and recitations.

Prerequisite: To be accompanied by Mathematics 9f.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first term, two lectures, two recitations and three hours' preparation per week.

Text: Spinney, *A Textbook of Physics.*

2f. GENERAL PHYSICS. (Woodman, Dorris)

The laboratory is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them.

Prerequisites: Mathematics 7w, and must be preceded or accompanied by 1f.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, first term, three hours per week.

3w. GENERAL PHYSICS. (Woodman)

This is a continuation of Course 1f and includes the study of electricity and magnetism, sound and light. Particular stress is laid upon electrical potential, resistance, and impedance, and upon the reflection, refraction, and interference of waves. Lectures, illustrated by experiments, and recitations.

Prerequisites: To be preceded by or accompanied by Mathematics 9f. Physics 1f.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, second term, two lectures, two recitations and three hours' preparation per week.

Text. Spinney, *A Textbook of Physics.*

4w. GENERAL PHYSICS. (Woodman, Dorris)

The work in the laboratory deals with the subjects studied in Physics 3w and the method is the same as that outlined in Physics 2f.

Prerequisite: Must be preceded or accompanied by Physics 3w.

Required in I., II., III., IV., V., VI. and VII.

Sophomore year, second term, three hours per week.

6f. ELECTRICAL MEASUREMENTS. *Laboratory.* (Frame)

This course will include a study of the various methods of measuring resistance, current strength, electromotive force, capacity, and inductance. Especial attention will be given to the potentiometer for calibrating ammeters and voltmeters and for the measurement of high temperatures.

Prerequisites: Physics 1f, 2f, 3w and 4w.

Required in VI.

Junior year, first term, six hours per week.

Text: Laws, *Electrical Measurements.*

7f, 7w. PRINCIPLES AND PRACTICE OF ELECTRICAL ENGINEERING. (Frame)

This course includes a discussion of the laws and properties of electric and magnetic circuits, a study of alternating currents, and a treatment of the principles of direct and alternating-current

machinery. It is designed to bring before the students the fundamental principles of electrical engineering.

Prerequisites: Physics 1f, 2f, 3w and 4w.

Required in V. and VI.

Junior year, first and second terms, three recitations and three hours' preparation per week.

Texts: Gray, *Principles and Practice of Electrical Engineering.*
Pender, *Principles of Electrical Engineering.*

8f, 8w. DYNAMO LABORATORY. (Frame)

This course accompanies Course 7f, 7w, and consists of calibration of instruments, measurements of ohmic and reactive resistances, insulation resistance, regulation and efficiency tests, of dynamos, motors, transformers, and converters.

It will also include the measurement of self and mutual induction, electro-magnetic induction, capacity and magnetic tests of iron and steel.

Prerequisites: Physics 1f, 2f, 3w and 4w.

Required in V. and VI.

Junior year, first and second terms, three hours per week.

11f, 11w. ELECTRICAL MACHINERY. (Frame)

In this course various types of direct and alternating current machinery are studied with reference to their construction, operation, and uses in power work and industrial processes.

Prerequisite: Physics 7w.

Required in VI.

Senior year, first and second terms, three recitations and three hours' preparation per week.

12f, 12w. ELECTRICAL MACHINERY. (Frame)

This course accompanies 11f and 11w, and is designed to familiarize the student with the characteristics and operation of the ordinary types of electrical machinery.

Prerequisites: Physics 7f and 7w.

Required in VI.

Senior year, first and second terms, three hours per week.

13f, 13w. ALTERNATING CURRENTS. (Woodman)

A continuation of Physics 7w and includes a rigorous analytical treatment of the subject as well as a study of the various practical applications in mining and metallurgy.

Prerequisites: Physics 7w and 8w.

Required in VI.

Senior year, first and second terms, three recitations and six hours' preparation per week.

Text: D. C. and J. P. Jackson, *Alternating Currents and A. C. Machinery.*

15f. ELECTRICAL COMMUNICATION. (Woodman)

This course will deal with the fundamental physical principles which underlie work in wireless telegraphy and wireless telephony.

Prerequisites: Physics 1f and 3w.

Elective.

Junior or senior year, first term, two recitations and four hours' preparation per week.

19w. ELECTRIC DISTRIBUTION. (Frame)

This course brings before the student problems of location of power house, size of conductors and transformers, lightning arresters, costs of systems and wiring for lights and power.

Prerequisites: Physics 7f and 7w.

Required in VI.

Senior year, second term, three recitations, three hours' preparation and six hours' laboratory and problem work per week.

21f. ELECTRIC RAILWAYS. (Frame)

The railway motor and auxiliaries; train performance; interurban railways, signal service, and estimated costs of the different parts of the system are gone into in this course.

Prerequisites: Physics 7f and 7w.

Elective, Senior year, first term, three recitations and six hours' preparation per week.

Advanced courses in electricity and magnetism, and light will be arranged by the department when there is a demand for such courses.

EXCURSIONS

During the summer the members of the Junior class are given the option of engaging in practical work at some mine, mill or smelter, or of making a trip to Colorado and Utah. The itinerary of this trip includes Denver, Idaho Springs, Central City, Georgetown, Silver Plume, Montezuma, Breckenridge, Leadville, Colorado Springs, Cripple Creek, Victor, and Pueblo in Colorado, and Salt Lake City, Garfield, and Bingham in Utah. Special attention is given to mining practice in the Clear Creek district, the Cripple Creek district, and Leadville and vicinity. Amalgamation is studied in the Clear Creek district, cyanidation at Colorado Springs and Victor; smelting of gold, silver, copper, and lead ores at Leadville and Pueblo; iron and steel metallurgy at Pueblo; treatment of zinc ores at Leadville.

During the Senior year a trip is made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast-furnace practice. Here may be studied the blast-furnace, regenerative stoves, blowing machinery, power plant, and other appliances necessary for the production of pig iron. Open-hearth steel methods and the manufacture of steel castings are studied at the plant of the Scullin Steel Company. This plant includes, in addition to the usual type of open-hearth furnace, Bessemer converters, cupolas, and gas-producers.

The metallurgy of zinc is studied at various plants, where the roasting of blende and distillation methods may be seen. The Federal Smelter, at Alton, is visited for the study of lead smelting. At this plant the lead blast-furnace, the Huntington-Heberlin roasting system, and the Scotch ore-hearths are carefully inspected. This plant also includes an extensive bag house. The manufacture of white-lead paint and of lead pipe is seen at the National Lead Works. A further study of lead smelting is made at Herculaneum, where blast furnaces are served by Dwight-Lloyd roasters. At the various plants enumerated, particular attention is paid to construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Company. This plant is one of the largest clay manufacturing works in the world and a metallurgist here has a splendid

opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

The class visits Southeast Missouri to study the geology, methods of mining, and the milling of great disseminated lead deposits. The geological work of this trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernible in relation to the contact plane between the pre-Cambrian and the Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain give interesting study in the distribution and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rocks in conjunction with jointing and stratification is well illustrated.

The concentration plants of Southeast Missouri are large and modern, containing crushers, rolls, elevating machinery, jigs, Wilfley tables, flotation installations and sundry other machines. The mining plants are thoroughly modern and include steam and electric hoists, modern steel head-frames, compressed air and electric haulage, extensive pumping plants, and numerous diamond-drill prospecting equipments.

An optional trip is given to Southwest Missouri for the purpose of studying the geology, mining and milling of the shallow deposits of zinc ores and the "sheet" ground mines. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electrical power to mining and milling is well illustrated in this district. Short trips are made to neighboring camps in Southwestern Kansas.

The students interested in coal mining are given an opportunity on the Senior trip to visit several of the large Illinois coal mines, in the vicinity of St. Louis, for the purpose of studying the up-to-date plants and modern methods in use in this district.

Practical work in mine surveying is a part of the Senior trip, and one week's time is devoted to the survey of a mine in the Southeast Missouri district or in the Illinois coal field. A complete survey and map of a portion of a mine is made during this time.

GENERAL INFORMATION

Fraternities.

There are five Greek-letter college fraternities, each maintaining a chapter house: Gamma XI of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha and Alpha Delta Zeta of Lambda Chi Alpha.

The engineering scholarship fraternity, Tau Beta Pi, established its Missouri Beta chapter in the school in 1908; and in 1916 the professional engineering fraternity, Theta Tau, installed its Iota chapter. On January 29, 1920, the scholarship fraternity, Phi Kappa Phi, installed its Missouri School of Mines chapter.

The Missouri Mining Association.

The objects of the Mining Association are: To advance the knowledge of mining among its members; to promote good fellowship among the students and alumni of the School of Mines and others interested in mining; and to bring the School into closer relation with the mining profession at large. Students in the School of Mines who have sixty-three credit hours on their course and alumni are eligible to membership.

This association is affiliated with the American Institute of Mining Engineers, and any member of it may become a junior member of the Institute. Such membership carries with it most of the privileges of regular membership at about one-half of the cost and with no initiation fee.

Officers of the Association for the year 1919-1920 are:

F. W. Uthoff, '20 . . . . *President.*
W. F. Netzeband, '21 . . . . *Secretary-Treasurer.*

Metallurgical and Chemical Society.

The Society meets fortnightly for the consideration and discussion of addresses, lectures, and informal talks on metallurgical and chemical topics—theoretical, practical, and industrial—delivered by students, faculty, and visiting professional men.

Students of metallurgy or chemistry with at least forty-three hours' credit are eligible as active members; other students having forty-three hours' credit or more may become associates.

The officers for 1919-1920 are:

K. K. Kershner, '19 . . . . *President.*
E. Dreidel, '21 . . . . *Secretary-Treasurer.*

Student Council.

The Student Council has for its object the promotion of various student enterprises and activities, and the maintenance of a spirit of mutual confidence in the student body and the faculty. The Council is composed of three Seniors and two Juniors, selected by the entire student body.

The members of the Council for 1919-1920 are:

O. E. Stoner, '20 (1st semester).
R. N. Stubbs, '20.
R. L. Marston, '20 (1st semester).
M. P. Brazill, '20 (2nd semester).
E. E. Ashlock, '20 (2nd semester).
H. O. Norville, '21.
K. W. Booker, '21.

Athletic Association.

The object of the Association is to unite the various efforts of the School in athletic sports. All students pay an athletic fee of five dollars a semester, which entitles them to membership in the Athletic Association, to admission to all athletic contests held under the auspices of the Athletic Association, and to golf club and gymnasium privileges. Members of the Faculty may become members of the Association by the payment of the stipulated fee. The Association elects its own officers and has general charge of all school athletics. The financial affairs of the Association are handled by a Board of Control. See page 000.

The officers of the Association for 1919-1920 are:

F. W. Uthoff, '20........................ *President.*
J. L. Howendobler, '20.................. *Vice-President.*
Edw. Kahlbaum............................ *Secretary-Treasurer.*
A. F. Delaloye, '21...................... *Business Manager.*
E. N. Murphy, '20........................ *Cheer Leader.*
E. M. Guy, '21........................... *Cheer Leader.*

The Rollamo.

The Rollamo, first published in 1907 by the fraternities, is now edited by a staff chosen from the entire student body. The publication is the official yearbook of the school, and chronicles in permanent form the activities of the school year.

The Board for 1919-1920 consists of the following:

K. M. Wright, '20..................... *Editor-in-Chief.*
G. E. Ebmeyer, '20.................... *Associate Editor.*
A. F. Delaloye, '21................... *Associate Editor.*

Joe M. Wilson, '21	*Art Editor.*
H. H. Hoppock, '20	*Athletic Editor.*
L. E. Davidson, '21	*Assistant Editor.*
G. B. Bloom, '21	*Secretary.*
A. B. Needham, '21	*Business Manager.*
C. P. Burford, '21	*Asst. Business Manager.*
M. S. Badollet, '20	*Photographer.*

The Missouri Miner.

The Missouri Miner is a weekly publication and was established in 1914-1915. It records the news of each week of interest to the student body and to the Alumni. It has been adopted as the official organ of the Alumni Association.

Staff for 1919-1920.

EDITORIAL.

G. E. Ebmeyer	*Editor-in-Chief.*
T. P. Walsh	*Associate Editor.*
G. F. Rackett	*Associate Editor.*
R. N. Stubbs	*Contributing Editor.*
E. L. Miller, Jr	*Contributing Editor.*
Joe M. Wilson	*Cartoonist.*

BUSINESS MANAGEMENT.

K. W. Booker	*Business Manager.*
O. Goldsmith	Assc. *Business Manager.*
W. F. Netzeband	*Asst. Business Manager.*
Homer Kerr	*Advertising Manager.*
W. R. Luckfield, Jr	*Circulation Manager.*
D. E. Huffman	*Asst. Circ. Manager.*

EXPENSES

Tuition Fee.

Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after January 1, 1909, non-residents of Missouri who matriculate in any Department of the University be required to pay a tuition fee of $20.00 per year."

Contingent Deposits.

A deposit of $15.00 is required from each student to cover the cost of extra supplies and damage to apparatus. This deposit must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Registration Fee.

By order of the Curators, a registration fee of $10.00 a term will be charged all students.

Laboratory Fees.

Chemistry.

2	General Chemistry Laboratory	$ 5.00
4	General Chemistry Laboratory	5.00
8	Analytical Laboratory	15.00
10	Quantitative Analysis	5.00

For each other laboratory course in Chemistry, a fee of $2.00 is charged and in addition the student pays for special chemicals used in the particular course.

Civil Engineering.

2	Plane Surveying	$3.00
4	Topography	3.00
7f	Railroad Surveying	2.00
13w	Highway Engineering	3.00
20f	Materials Testing	4.00

Drawing.

2f	Beginning Drawing	$1.50
2w	Advanced Drawing	1.50
4w	Machine Drawing	1.00
6f	Topographical Drawing	1.00

Geology and Mineralogy.

1f	Crystallography	$1.00
1w	Mineralogy	5.00
2f	General Engineering Mineralogy	2.00
4w	General Geology	2.00
5f	Lithology	2.00
11f	Petrography	3.00
11w	Petrography	2.00
14f	Field Geology	5.00
18w	Oil and Gas	2.00

Mechanical Engineering.

4w	Machine Shop and Forge	$2.50
6f	Steam Laboratory	2.00
8w	Mechanical Laboratory	4.00
9f	Power Plants	2.00
11f	Compressed Air	2.00
12f	Woodwork	2.50
14f	Forge	2.50
16f	Foundry and Pattern Making	2.50
18w	Machine Shop	2.50

Metallurgy and Ore Dressing.

2	Fire Assaying	$25.00
4	Fire Assaying	18.00
6	Fire Assaying	10.00
7w	General Metallurgy Laboratory	4.00
12f	Non-Ferrous Metallurgy	3.00
12w	Non-Ferrous Metallurgy	3.00
18w	Electrometallurgy Laboratory	2.50
22f	Ore Dressing Laboratory	2.00
22w	Ore Dressing Laboratory	2.00
32f	Alloys and Metallography	2.00
36w	Alloys and Metallography	3.00
38w	Alloys and Metallography	4.00
46w	Cyanide Laboratory	3.00

Mining.

4w	Mining Laboratory	$2.50
6w	Mine Surveying	1.00
16w	Mining Laboratory	2.50

Physics and Electrical Engineering.

2f	Physics Laboratory	$2.00
4w	Physics Laboratory	2.00
6f	Electrical Measurements	4.00
8f	Dynamo Laboratory	2.00
8w	Dynamo Laboratory	2.00
12f	Electrical Machinery Laboratory	2.00
12w	Electrical Machinery Laboratory	2.00

Gymnasium and Athletic Fee . . . . 5.00 a term
Diploma Fee 5.00

A student who has to repeat a laboratory course will be charged a second fee for that course. For finishing an incomplete laboratory course, a pro rated additional fee will be charged.

The Senior trip to Southeast Missouri costs from $60.00 to $75.00.

Room rent costs from $6.00 to $10.00 a month.

Table board in 1919-20 costs from $26.00 to $30.00 a month.

JACKLING LOAN FUND

Loans may be made to students of the School of Mines from the Jackling Loan Fund under the following conditions:

1. The student must have been in attendance at the School of Mines one semester.

2. Written requests for loans must be filed with the Director to be considered at the following meeting of the Executive Committee.

The parent or guardian must sign the note with the student.

4. No loans of more than one hundred dollars may be made to any one student during the calendar year.

5. The student shall give his note for the amount of the loan, which note shall bear interest at the rate of five per cent per annum from the date of the note to one year after his graduation or his leaving the School of Mines, and for one year following at the rate of eight per cent per annum. The note shall then become due.

The purpose of the Jackling Loan Fund is to help worthy students who require financial assistance and who are unable to borrow money from other sources.

Since its establishment in 1909, eighty-one young men have been helped by this fund. At present nineteen young men are being helped by loans.

THE MINING EXPERIMENT STATION

Officers of the Station.

ALBERT ROSS HILL, Ph. D., LL. D..... *President of the University.*
AUSTIN LEE MCRAE, S. D........... *Director.*
GUY HENRY COX, Ph. D., E. M....... *Geology and Mineralogy.*
CARROLL RALPH FORBES, E. M........ *Mining.*
WILLIAM DEGARMO TURNER, Ph. D.... *Chemistry.*
CHARLES YANCEY CLAYTON, Met. E.... *Metallurgy.*
MARTIN HARMON THORNBERRY, B. S... *Research Assistant.*

The Mining Experiment Station was established June 1, 1909.

It is the object of the station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters; to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and metallurgical engineering to the mineral industry of the State of Missouri.

The following bulletins were issued during the year:

Bibliography of Roasting, Leaching, Smelting and Electrometallurgy of Zinc, by H. L. Wheeler.

The Effect of Addition Agents in Flotation, Part II, by M. H. Thornberry and H. T. Mann.

Road Problems in the Ozarks, by E. G. Harris. Second edition, rewritten and enlarged.

The Carbonization of Missouri Cannel Coals, by H. L. Dunlap.

An Investigation of the Xylenes obtained from the Carbonization of Coal, by W. D. Turner.

Any resident of the State may on request obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Correspondence regarding these bulletins or the work of the Station may be addressed to the Director, Mining Experiment Station, Rolla, Missouri.

BUREAU OF GEOLOGY AND MINES

The Geological Survey of the State of Missouri has its headquarters at Rolla, and occupies the Rolla Building on the School campus.

Board of Managers.

GOVERNOR FREDERICK D. GARDNER, Jefferson City, President.

ELIAS S. GATCH, St. Louis, Vice-President.

CLARK CRAYCROFT, Joplin, Secretary.

EDWARD M. SHEPARD, Springfield, Chairman of Publication Committee.

PHILIP N. MOORE, St. Louis.

State Geologist.

H. A. BUEHLER.

Equipment and Investigations.

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects, and a museum of seven thousand specimens of clay, coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri.

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of geology to the ore deposits is also worked out and detailed reports published concerning such investigations.

The Department has the following reports available for distribution at the present time:

Preliminary Report	Vol. XIII.
Geology of Miller County	Vol. I., 2d series.
Quarrying Industry of Missouri	Vol. II., 2d series.
Geology of Moniteau County	Vol. III., 2d series.
Geology of the Granby Area	Vol. IV., 2d series.
Public Roads	Vol. V., 2d series.
Lime and Cement Resources of Missouri	Vol. VI., 2d series.
Geology of Morgan County	Vol. VII., 2d series.
Geology of Pike County	Vol. VIII., 2d series.
Geology of the Disseminated Lead Deposits of St. Francois and Washington Counties	Vol. IX., 2d series.
Iron Ores of Missouri	Vol. X., 2d series.
Coal Deposits of Missouri	Vol. XI., 2d series.
Geology of the Rolla Quadrangle	Vol. XII., 2d series.
The Stratigraphy of the Pennsylvanian Series of Missouri	Vol. XIII., 2d series.
Geology of Jackson County	Vol. XIV.
Sand and Gravel Resources of Missouri	Vol. XV.

DEGREES CONFERRED IN 1919. COMMENCEMENT EXERCISES APR. 26, 1919

Engineer of Mines.

Preston King Horner, B. S. '06
Gilbert Frank Metz, B. S. '14

Metallurgical Engineer

James Pressley Gill, B. S. '18
Knud Fabricius Hansen, B. S. '18
Clarence Eugene Peterson, B. S. '16
Frank Lewis Leonard Wilson, B. S. '08

Bachelor of Science in Mine Engineering.

Louis Brent Benton
Philip Harris Bohart
Thomas Ralph Crawford
Raymond John Dowd
Joseph Benjamin Duga
John Munson Morris
Thomas Carson Morris
Charles Michael Schnaidt

Bachelor of Science in Metallurgy.

James Walter Scott
Vivien Xly Smiley

Bachelor of Science in General Science.

Harry Gilham Smith

Bachelor of Science in Mechanical Engineering.

Walter Frederick Lottman

Bachelor of Science in Chemical Engineering.

Banjamin Guthrie Nichols
William Ellsworth Oyler
Paul DeLassus Wilkinson

STUDENTS.

SUMMER SCHOOL, 1919.

Aid, Kenneth	*Gallatin, Mo.*
Albert, Hyman Isidore	*St. Louis, Mo.*
*Axton, Elmer Ray	*Joplin, Mo.*
Badollet, Marion Smith	*Rolla, Mo.*
Bailey, Harold Leland	*Virginia, Ill.*
Bash, David Anderson	*Hannibal, Mo.*
Baysinger, Helen J.	*Rolla, Mo.*
Beyer, Daniel Christopher	*Rolla, Mo.*
Booker, Karl William	*Kansas City, Mo.*
Brandenburger, Oscar Louis	*Belleville, Ill.*
Brazill, Matthew Patrick	*St. Louis, Mo.*
Burford, Carroll Preston	*Beaumont, Tex.*
Cairns, Arthur Lee	*Cape Girardeau, Mo.*
De Cardenas, Emilio	*La Paz, Bolivia.*
Casanovas, Juan Rafael	*Baracoa, Cuba.*
Case, Walker Ernest	*Rolla, Mo.*
Casselman, Lawrence Owen	*Rolla, Mo.*
Chang, Kuang Yu	*Kung-Hsien, Honan, China.*
*Cloud, Noah	*Aurora, Mo.*
Colbert, Jules Philip	*Maryville, Mo.*
Cornwell, Benjamin Sedgely	*St. Louis, Mo.*
De Cousser, Kurt Herman	*Rolla, Mo.*
Crawford, Howard Stanley	*Rivera, Cal.*
Davidson, Lewis Ely	*Savannah, Mo.*
Devereux, Andrew	*Pachuca, Mexico.*
Dreidel, Eugene	*St. Louis, Mo.*
*Farmer, Samuel Dewitt	*Galena, Kan.*
Finlay, William James	*Webster Groves, Mo.*
Fischlowitz, Victor Kopple	*St. Louis, Mo.*
Gerber, Clarence Oliver	*Kansas City, Mo.*
Gettler, Carl Andrew	*Hannibal, Mo.*
Goldman, Leon Harrison	*St. Louis, Mo.*
Hagood, Lindell	*Marshall, Mo.*
Hahn, Abner Decker	*Rolla, Mo.*
Hahn, Daisy Mildred	*Rolla, Mo.*
Hayes, Stanley Merton	*Wellsville, Mo.*
Hazeltine, Richard Gibson	*St. Louis, Mo.*
Heckman, Ren Marlin	*Liberty, Kan.*

Vocational.

Hippard, Wesley George	*Belleville, Ill.*
Howald, Arthur Mark	*Rolla, Mo.*
Hughes, Harry Herbert	*Santa Monica, Cal.*
Hunt, Russell Wayne	*Independence, Mo.*
Johnson, Richard Love	*Joplin, Mo.*
Kennedy, Ernest Carlton	*Ranger, Tex.*
Kershner, Karl Kenneth	*St. Louis, Mo.*
Kilpatrick, Henry Gray	*St. Louis, Mo.*
Knight, Ralph Henry	*St. Louis, Mo.*
Krause, Frederick Arthur	*St. Louis, Mo.*
Lanning, Sarah	*Rolla, Mo.*
Larsh, Napoleon Bonaparte	*Nebraska City, Neb.*
Leach, Thomas Witt	*Pine Bluff, Ark.*
Lingsweiler, John Wallace	*Richland, Mo.*
Lloyd, Samuel Horace, Jr	*St. Louis, Mo.*
Loesche, Harry Charles	*St. Louis, Mo.*
Long, Albert Edwin	*Rolla, Mo.*
MacCallum, John Seaver	*Joplin, Mo.*
McGirl, James Nathaniel	*Odessa, Mo.*
McMillen, Frank Morris	*Branson, Mo.*
Ma, Heng Yung	*Anyang, Honan, China.*
Marston, Robert L	*Rolla, Mo.*
Miller, John Gaines	*Marshall, Mo.*
Moore, Fred Vail	*University City, Mo.*
Nolte, William John	*St. Louis, Mo.*
Norville, Glen Smith	*Beardstown, Ill.*
Norville, Howard Oliver	*Rolla, Mo.*
Novak, Joseph, Jr	*St. Louis, Mo.*
Ohnsorg, Edward George	*Alton, Ill.*
*Puekert, William Henry	*Macon, Mo.*
Petsch, Arthur Henry	*Lexington, Mo.*
Pietsch, Peter Harold	*Chicago, Ill.*
Potts, Allen Dewey	*Pittsburg, Pa.*
Richards, Robert Earl	*Hutchinson, Kan.*
Salmon, Julius Clarence	*Rayville, La.*
Schappler, Rudolph Charles	*Springfield, Mo.*
Schumacher, Leon Burr	*St. Louis, Mo.*
Shanfeld, Samuel Norman	*St. Louis, Mo.*
Shih, Hsin Pu	*Chiyuan, Honan, China.*
Smith, Charles Landon	*Rolla, Mo.*
Smith, James Alger	*Steelville, Mo.*
Smith, Peyton Wemyss	*Oklahoma City, Okla.*
Stevens, Thomas Adrian	*Caney, Kan.*
Stewart, William Lincoln	*Pittsburg, Pa.*
Stubbs, Robert Newton, Jr	*Kirkwood, Mo.*

*Vocational.

*Stuerman, Harold Arthur............St. Louis, Mo.
Taggart, William Miskey, Jr.........St. Louis, Mo.
Taulbee, Kelly Lyons................Joplin, Mo.
Tragitt, Edmund Rowland.............Rolla, Mo.
Webb, Albert Loomis.................El Paso, Tex.
Weigel, William Walbridge...........Fredericktown, Mo.
*Weldon, Elzia Bryan................Fremont, Mo.
White, Fred Pope....................St. Louis, Mo.
Williams, Edgar Arthur..............Withers Mill, Mo.
Wills, Ronald Blair.................Rolla, Mo.
Wright, Kenneth Maurice.............Kansas City, Mo.
*Yeager, Robert Lee.................Joplin, Mo.
Zieseniss, Harry Wesley.............Rolla, Mo.

*Vocational.

GRADUATE STUDENTS

Ambler, Harry Atwood, B. S., '17.....St. Louis, Mo.
*Ambler, John Owen, B. S. '06.......Clifton, Ariz.
*Barton, Joseph C., B. S., '17........Ashland, Ala.
*Boucher, Leonidas James, B. S., '14...Hannibal, Mo.
*Deutmann, Earl George, B. S., '16...Cuba City, Wis.
*DeWaters, Roy Hayward, B. S., '09..Argo, Ill.
*Dolman, Phillips Brooks, B. S., '17...Tulsa, Okla.
*Elfred, Frank Stillman, Jr., B. S., '17..Baxter Springs, Kan.
Frame, Floyd Hill, A. B., '12, Clark College............................Rolla, Mo.
*Hall, William Simpson, B. S., '09.....Hurley, N. Mex.
*Ham, Roscoe Conkling, B. S., '09....Kansas City, Mo.
Howald, Arthur Mark...............Rolla, Mo.
Kershner, Karl Kenneth.............St. Louis, Mo.
*Knickerbocker, Ray Gould, B. S., '13. Messina, Transvaal, S. A.
*McNely, Earl Joesting, B. S., '16....Wood River, Ill.
*Miller, John Charles, B. S. '16.......Tulsa, Gkla.
*Needles, Enoch Ray, B. S., '14......Kansas City, Mo.
Thornberry, Martin Harmon, B. S., '12. Rolla, Mo.
*Trent, Albert Leo, B. S., '15..........Johnstown, Pa.
Walsh, Thomas Patrick, B. S., '17....St. Joseph, Mo.
Weiser, Hanley, B. S., '18............St. Louis, Mo.

*In absentia.

CLASS OF 1920

MINE ENGINEERING

Aid, Kenneth........................*Gallatin, Mo.*
Beyer, Daniel Christopher...........*Long Island City, N. Y.*
Brazill, Matthew Patrick, Jr.........*St. Louis, Mo.*
Casselman, Lawrence Owen..........*Columbia, Mo.*
Cunningham, Lorain Harry..........*Columbus, Kan.*
Ebmeyer, Gerard Ernest.............*Lincoln, Neb.*
Eulich, Artileus Vosteen.............*St. Joseph, Mo.*
Gerber, Clarence Oliver..............*Kansas City, Mo.*
Goldsmith, Osher...................*Dallas, Tex.*
Hippard, Wesley George.............*Belleville, Ill.*
Hoppock, Harland Hobart...........*Joplin, Mo.*
Howard, Clifford Peter..............*Wilburton, Okla.*
Howendobler, John Leslie............*Tulsa, Okla.*
Leach, Thomas Witt................*Pine Bluff, Ark.*
Lucky, Maurice Cecil...............*Balmorhea, Tex.*
McMillen, Frank Morris.............*Branson, Mo.*
Marston, Robert L..................*El Paso, Tex.*
Moore, Frederick Vail...............*University City, Mo.*
Murphy, Earle Nelson...............*Vinita, Okla.*
Niece, William Latchaw.............*Tulsa, Okla.*
Nolte, William John.................*St. Louis, Mo.*
Petsch, Arthur Henry...............*Lexington, Mo.*
Rackett, Gerald Franklin............*Chicago, Ill.*
Schappler, Rudolph Charles, A. B., Conception College; A. M., Catholic University...................*Springfield, Mo.*
Sherwood, Theodore Clayton, Jr......*Kansas City, Mo.*
Stoner, Oscar Eli...................*Chester, Neb.*
Uthoff, Frederick William............*St. Louis, Mo.*
Weigel, William Walbridge...........*Fredericktown, Mo.*
Wright, Kenneth Maurice............*Kansas City, Mo.*

METALLURGY

Cairns, Arthur Lee...................*Cape Girardeau, Mo.*
Hummel, Carl Bernard..............*Kansas City, Mo.*
Kroenlein, George Alfred............*St. Louis, Mo.*
Miller, John Gaines, Jr..............*Marshall, Mo.*
Potts, Allen Dewey.................*Pittsburg, Pa.*
Slover, Edwin Allsop................*East Orange, N. J.*
Stubbs, Robert Newton, Jr...........*Kirkwood, Mo.*
Swayze, Ronald Owen...............*Pomona, Kan.*
Terry, Mark Loren..................*Galt, Mo.*
Velasco, Rafael Esteban.............*San Luis Potosi, Mexico.*

CIVIL ENGINEERING

Ashlock, Evan Earl . . . . *St. Louis, Mo.*
Bardsley, Clarence Edward . . . . *St. Louis, Mo.*
Barnard, Charles Russell . . . . *St. Louis, Mo.*
Bohn, Edwin Joseph . . . . *St. Louis, Mo.*
Burnet, George . . . . *St. Louis, Mo.*
Heimberger, Karl William . . . . *Rolla, Mo.*
McCarthy, Meryl . . . . *Bowling Green, Mo.*
Novak, Joseph, Jr . . . . *St. Louis, Mo.*
Schuman, Edwin Kaine, LL. B., University of Missouri, '18 . . . . *Rolla, Mo.*
Wills, Ronald Blair . . . . *Evansville, Ind.*
Zieseniss, Harry Wesley . . . . *Rolla, Mo.*

GENERAL SCIENCE

Bruce, Robert . . . . *Wellington, Kan.*
Pietsch, Peter Harold . . . . *Chicago, Ill.*
Shaw, William Frederick, M. D., University of Kansas . . . . *Rolla, Mo.*

MECHANICAL ENGINEERING

Taggart, William Miskey, Jr . . . . *St. Louis, Mo.*

CHEMICAL ENGINEERING

Badollet, Marion Smith . . . . *Vincennes, Ind.*
Bash, David Anderson . . . . *Hannibal, Mo.*
Gettler, Carl Andrew . . . . *Hannibal, Mo.*
Kahlbaum, William McKinley . . . . *Rolla, Mo.*
Williams, Edgar Arthur . . . . *Withers Mill, Mo.*

CLASS OF 1921

MINE ENGINEERING

Albert, Hyman Isadore . . . . *St. Louis, Mo.*
Allison, Harold Farris . . . . *Caddo, Tex.*
Bailey, Harold Leland . . . . *Virginia, Ill.*
Booker, Karl William . . . . *Kansas City, Mo.*
Burford, Carroll Preston . . . . *Beaumont, Tex.*
Chang, Kuang Yu . . . . *Kung-Hsien, Honan, China.*
Charles, Beryl Elwood . . . . *Salina, Kan.*
Colbert, Jules Philip . . . . *Maryville, Mo.*
Davidson, Lewis Ely . . . . *Savannah, Mo.*
Delaloye, August Francis . . . . *Rolla, Mo.*
Denison, William Ray . . . . *Rolla, Mo.*
Donai, Willard Bartholomew . . . . *Des Moines, Iowa.*
Forman, Percy Grant . . . . *Shelbina, Mo.*
Guy, Earl McKinley . . . . *Davenport, Iowa.*

Hahn, Abner Decker . . . . *Muscatine, Iowa.*
Harlowe, Leslie Steele . . . . *Covington, Ind.*
Hollingshead, Homer Archer . . . . *St. Joseph, Mo.*
Hughes, Harry Herbert, Jr . . . . *Springfield, Mo.*
Hurd, Harold Waller . . . . *Paris, Mo.*
Hurst, Henry William . . . . *Kansas City, Mo.*
Illidge, Robert Eugene . . . . *Corbett, Ore.*
Kerr, Homer Chalmers . . . . *Rolla, Mo.*
Ma, Heng Yung . . . . *Anyang, Honan, China.*
McComb, William Randolph . . . . *St. James, Mo.*
McGirl, James Nathaniel . . . . *Odessa, Mo.*
Miller, Edwin Lawrence, Jr . . . . *Kansas City, Mo.*
Mundt, Herbert William . . . . *St. Louis, Mo.*
Mutz, Herman Jacob . . . . *Elizabethtown, N. Mex.*
Needham, Albert Booth . . . . *Collinsville, Ill.*
Netzeband, William Ferdinand . . . . *St. Louis, Mo.*
Nighswonger, Ray Dean . . . . *Cameron, Mo.*
Norville, Howard Oliver . . . . *Beardstown, Ill.*
Patterson, Harold Ford . . . . *Warrensburg, Mo.*
Quilliam, William Reed . . . . *Fowlerton, Tex.*
Salmon, Julius Clarence, Jr . . . . *Rayville, La.*
Schumacher, Leon Burr . . . . *St. Louis, Mo.*
Scruby, Horace Dwight . . . . *Chillicothe, Mo.*
Sherman, Benjamin Edward . . . . *Tahlequah, Okla.*
Shore, Harold Francis . . . . *Chillicothe, Mo.*
Stewart, William Lincoln, Jr . . . . *Pittsburg, Pa.*
Stroup, Richard John . . . . *Quincy, Ill.*
Webb, Albert Loomis . . . . *El Paso, Tex.*
White, Frederick Pope . . . . *East St. Louis, Ill.*
Wilson, James Mortimer . . . . *Hannibal, Mo.*
Wilson, Joseph Martland . . . . *Rock Rapids, Iowa.*
Wilson, Kenneth Campbell . . . . *Globe, Ariz.*

METALLURGY

Crow, Wayman . . . . *St. Louis, Mo.*
Dorris, Milburn Leo . . . . *Collinsville, Ill.*
Johnson, Richard Love . . . . *Henryetta, Okla.*
Rohloff, Joseph Herman . . . . *St. Joseph, Mo.*
Shanfeld, Samuel Norman . . . . *St. Louis, Mo.*
Shih, Hsin Pu . . . . *Chi Yuan, Honan, China.*
Stevens, Thomas Adrian . . . . *Caney, Kan.*

CIVIL ENGINEERING

Place, Roscoe Nelvin . . . . *Gallatin, Mo.*
Stubbins, John Russell . . . . *Paris, Mo.*
Williams, Anvil Clark . . . . *Sullivan, Mo.*

GENERAL SCIENCE

Bloom, George Barnett . . . . *Maysville, Mo.*
Luckfield, William Richard . . . . *Kansas City, Mo.*
Mann, Marion Robert . . . . *Gallatin, Mo.*

ELECTRICAL ENGINEERING

Keeter, Vern Ivan . . . . *Maysville, Mo.*
Lumpkin, Loyd Earl . . . . *Jefferson City, Mo.*
Wallace, Milton Wardell . . . . *East Orange, N. J.*

CHEMICAL ENGINEERING

Dreidel, Eugene . . . . *St. Louis, Mo.*
Fischlowitz, Victor Kopple . . . . *St. Louis, Mo.*
Kosky, John . . . . *St. Louis, Mo.*
Laun, Albert Charles . . . . *St. James, Mo.*
Lloyd, Samuel Horace, A. B., '18, De Pauw University . . . . *Vincennes, Ind.*
Millar, Charles James . . . . *Webb City, Mo.*
Nevedomsky, Samuel Leonard . . . . *St. Louis, Mo.*
Nudelman, Barney . . . . *St. Louis, Mo.*

SOPHOMORE CLASS OF 1922

MINE ENGINEERING

Ackers, Albert Louis . . . . *Staunton, Ill.*
Ahrens, Herbert Emmett . . . . *Corning, Mo.*
Arnold, Paul Caldwell . . . . *Tulsa, Okla.*
Baxter, William Hampton . . . . *Oklahoma City, Okla.*
Bolt, William Weeks . . . . *Springfield, Ill.*
Brandenburger, Oscar Louis . . . . *Belleville, Ill.*
Bulger, John Leo . . . . *Gouverneur, N. Y.*
de Cardenas, Emilio . . . . *La Paz, Bolivia.*
Childress, Harold Lyle . . . . *Galena, Kan.*
Christner, Glen Joyce . . . . *Horton, Kan.*
Coffman, Frank W . . . . *Liberty, Mo.*
DeCousser, Kurt Herman . . . . *Rolla, Mo.*
Crouse, George Todd . . . . *Kansas City, Mo.*
Denison, Alvis Frederick . . . . *Cushman, Ark.*
Devereux, Andrew . . . . *Puchuca, Hgo., Mexico.*
Diers, George Peter . . . . *East Orange, N. J.*
Dover, Fayette Lee . . . . *St. Louis, Mo.*
Evans, John Raymond . . . . *Chillicothe, Mo.*
Frazier, Alexander Joseph . . . . *Beardstown, Ill.*
Gollub, Meyer . . . . *St. Louis, Mo.*
Hagood, Lindell . . . . *Marshall, Mo.*

Hammer, Bernardi Eli................*Stanton, Mo.*
Hatmaker, Paul Castleton...........*Gouverneur, N. Y.*
Henderson, Frank Irving............*St. Louis, Mo.*
Hoke, William Franklin.............*Lees Summit, Mo.*
Hunt, Russell Wayne...............*Independence, Mo.*
Jewell, James Edwin, Jr............*Kansas City, Mo.*
Jones, James Ewart.................*Pasadena, Cal.*
Kaley, Charles Bayard..............*Gouverneur, N. Y.*
Keeler, Edgar Allen.................*Tulsa, Okla.*
Keeler, William Weaver.............*Tulsa, Okla.*
Long, Albert Edwin.................*Rolla, Mo.*
Metzger, William Herman...........*East St. Louis, Ill.*
Mize, Charles Roderick.............*Independence, Mo.*
Moore, Robert Douglass.............*Carthage, Mo.*
Packman, Nathan...................*St. Louis, Mo.*
Place, Otis Kipling..................*Gallatin, Mo.*
Reid, Sidney Kincaid................*McAlester, Okla.*
Richards, Robert Earl...............*Hutchinson, Kan.*
Rixleben, Bruno.....................*Jonesboro, Ill.*
Signer, Merton Ira..................*Tonica, Ill.*
Smith, Charles Landon..............*Rolla, Mo.*
Smith, Payton-Wemyss..............*Oklahoma City, Okla.*
Smith, Ralph Day...................*Hutchinson, Kan.*
Tragitt, Edmund Rowland...........*Rolla, Mo.*
Watts, Audrey Byron...............*Fredericktown, Mo.*
Weir, Thomas Glover...............*Webster Groves, Mo.*
Windsor, Paul Donovan.............*Belleville, Ill.*
Wolverton, Thatcher Siprell..........*Green River, Utah.*
Wyman, Glen Sherman..............*Kansas City, Mo.*

METALLURGY

Alcorn, Irwin Wyland...............*Robinson, Ill.*
Coffey, Glen Verlan.................*LaFontaine, Ind.*
Diers, Henry Ernest.................*East Orange, N. J.*
Fischer, Otto Ernest, Jr............*St. Louis, Mo.*
Gettler, Warren Roy................*Hannibal, Mo.*
Hosterman, John Francis............*Kansas City, Mo.*
Huffman, Daniel Elijah, Jr..........*St. Louis, Mo.*
Kilpatrick, Henry Gray..............*St. Louis, Mo.*
Kimmel, Victor Edward.............*Rochester, N. Y.*
Leonard, Homer Lakirby............*Rolla, Mo.*
Teis, Kenneth Robert...............*Parkville, Mo.*

CIVIL ENGINEERING

Dougherty, John Herman . . . . *Peoria, Ill.*
Erickson, Roy . . . . *Madrid, Iowa.*
Kaullen, Frederick Adam . . . . *Jefferson City, Mo.*
Kenyon, Ronald John . . . . *Rolla, Mo.*
Kenyon, Russell George . . . . *Rolla, Mo.*
Machin, Edwin Gilbert . . . . *Bluffton, Mo.*

GENERAL SCIENCE

Gholson, John D . . . . *Ranger, Tex.*
Uthoff, Carl Joseph . . . . *Chicago, Ill.*
Whitworth, Virgil Lee . . . . *Nevada, Mo.*

MECHANICAL ENGINEERING

Boyle, Alfred Arthur . . . . *St. Louis, Mo.*
Hayes, Stanley Merton . . . . *Wellsville, Mo.*
Stassen, Robert Henry . . . . *Rolla, Mo.*
Whitaker, Uncas Aeneas . . . . *Weaubleau, Mo.*

ELECTRICAL ENGINEERING

Case, Walker Earnest . . . . *Rolla, Mo.*
Halasey, Francis Richard . . . . *Maryville, Mo.*

CHEMICAL ENGINEERING

Ehler, Otto . . . . *Washington, Mo.*
Harbison, Lynn . . . . *Kansas City, Mo.*
Heckman, Ren Maclin . . . . *Liberty, Kan.*
Heid, John Laurence . . . . *Cairo, Ill.*
Karges, Paul Henry . . . . *Kansas City, Mo.*
Knight, Ralph Henry . . . . *St. Louis, Mo.*
Loesche, Harry Charles . . . . *St. Louis, Mo.*
Ottersbach, David Maurice . . . . *St. Louis, Mo.*
Rembert, Ernest Wayne . . . . *Jefferson City, Mo.*
Wheeler, Ernest Sterling . . . . *Madrid, Iowa.*

CLASS OF 1923

Ananos, Raul Alfredo . . . . *Ayacucho, Peru, S. A.*
Anderson, Robert Chamblin . . . . *Higginsville, Mo.*
Andrews, John Lewis . . . . *Puxico, Mo.*
Askins, Benjamin Franklin . . . . *Cuba, Mo.*
Backer, William . . . . *Webster Groves, Mo.*
Barter, Louis Schnur . . . . *Mt. Vernon, Ind.*
BeDell, Milo Nanson . . . . *St. Louis, Mo.*
Bowman, Kingston Miller . . . . *Keokuk, Iowa.*
Burch, Ivan C . . . . *Georgetown, Ill.*
Burke, Stephen Michael . . . . *St. Louis, Mo.*

Buser, Henry Clarence . . . . *Webster Groves, Mo.*
Campbell, Joseph Lambert . . . . *Rolla, Mo.*
Canales, Francisco Alexander . . . . *Ayacucho, Peru, S. A.*
Cantwell, Lucius . . . . *St. Louis, Mo.*
Cassil, Lawrence A . . . . *Mountain Grove, Mo.*
Cathcart, Everett Hunter . . . . *Kansas City, Mo.*
Chapin, Elmer Fenton . . . . *East St. Louis, Ill.*
Chappuis, Alfred Starkloff . . . . *Springfield, Mo.*
Chomeau, Henri . . . . *Clayton, Mo.*
Corenbaum, Jacob Israel . . . . *Pawtucket, R. I.*
Dierking, George Thomas . . . . *St. Louis, Mo.*
Dooley, Glenn Angus . . . . *Joplin, Mo.*
Dunlap, Myron Norman . . . . *Monett, Mo.*
Fischer, Paul Edgar . . . . *Webster Groves, Mo.*
Fleck, Howard . . . . *El Paso, Tex.*
Frame, Wayne Shannon . . . . *Salesville, Ohio.*
Frey, Muir Luken . . . . *Bunker Hill, Ill.*
Gallaway, Nixon Burton . . . . *South Bend, Ind.*
Gallaway, Robert Samuel . . . . *South Bend, Ind.*
Gatts, William Prescott . . . . *Hannibal, Mo.*
Gibson, Dod Graham, Jr . . . . *Webster Groves, Mo.*
Gordon, John Pemberton, Jr . . . . *Jefferson City, Mo.*
Grady, Robert Franklin, Jr . . . . *St. Louis, Mo.*
Gregg, James Lawrence . . . . *Independence, Mo.*
Harper, Robert Gladstone . . . . *Kennett, Mo.*
Harris, James Van . . . . *Morley, Mo.*
Healey, Michael Vincent . . . . *Macon, Mo.*
Heckenberg, Edgar William . . . . *St. Louis, Mo.*
Hegwer, Paul Jent . . . . *Sarcoxie, Mo.*
Hendry, David John . . . . *St. Louis, Mo.*
Hoffman, Ralph Andrew . . . . *Wichita Falls, Tex.*
Hollow, Francis Herron . . . . *Cuba, Mo.*
Homer, St. Clair . . . . *Caddo, Okla.*
Hoover, B. F . . . . *Trenton, Mo.*
Hubbard, Henry Guernsey . . . . *Crescent City, Fla.*
Hunter, Francis Kinlock Middleton . . . *Spuyten Duyvil, N. Y.*
Jameson, Charles William . . . . *Ft. Smith, Ark.*
Jewell, Armin Brene . . . . *Kansas City, Mo.*
Johnson, Walter Virgil . . . . *Cuba, Mo.*
Kasel, Rudolph Gustave . . . . *Washington, Mo.*
Keyes, Irwin Wilson . . . . *Richmond, Mo.*
Kitchen, William Anthony . . . . *Rolla, Mo.*
Knight, Jesse Ray . . . . *Gallatin, Mo.*
Kratz, Francis Oliver . . . . *Iola, Kan.*
Lapee, Roland Joseph . . . . *Sullivan, Mo.*
Layton, Benjamin McColloch . . . . *St. Louis, Mo.*
Lindgren, Roy Alexander . . . . *Chicago, Ill.*

Linzer, Leo Morris . . . . . *New York City, N. Y.*
McBride, Hollis Eugene . . . . . *Cape Girardeau, Mo.*
McClellan, Maurice Hunter . . . . . *Eminence, Mo.*
McHugh, Owen Paul . . . . . *Hartshorne, Okla.*
McKee, Samuel Joseph . . . . . *Joplin, Mo.*
McKey, Howard Eugene . . . . . *St. Louis, Mo.*
Martyn, Phillip Francis . . . . . *Cuba, Mo.*
Matlack, Fred Palmore . . . . . *Overland, Mo.*
Meeks, Felix Zollicoffer . . . . . *Marshall, Mo.*
Meinecke, Egmont Samuel . . . . . *Bay, Mo.*
Mennie, Billy Raymond Walker . . . . . *Hannibal, Mo.*
Millikan, Carl E . . . . . *Buffalo, N. Y.*
Moore, Hamilton . . . . . *St. Louis, Mo.*
Mosby, Donald Speed . . . . . *Jefferson City, Mo.*
Mosena, Charles Clifford . . . . . *Falls City, Neb.*
Murch, William Numan . . . . . *St. Louis, Mo.*
Murphy, James Kenneth . . . . . *Vinita, Okla.*
Murphy, Raymond Edward . . . . . *Galena, Ill.*
Nangle, Harold Atley . . . . . *Caney, Kan.*
Nawn, George Francis . . . . . *Rolla, Mo.*
Nunnally, Hilliard Nolan . . . . . *Texarkana, Tex.*
Ohnsorg, Edward George . . . . . *Alton, Ill.*
Ormsbee, Joseph Leroy . . . . . *Strawn, Tex.*
Orr, Raymond Fitzgerald . . . . . *Webb City, Mo.*
Owens, Irvin King . . . . . *St. Louis, Mo.*
Pace, Henry Harding . . . . . *Alton, Ill.*
Parkhurst, Arlis Becham . . . . . *Tulsa, Okla.*
Pence, Harry Simanton . . . . . *Falls City, Neb.*
Pesout, Edward . . . . . *St. Louis, Mo.*
Pitman, Raymond Oatis . . . . . *Carterville, Mo.*
Porter, Edwin Kemp . . . . . *Holden, Mo.*
Porterfield, Hubert Preston . . . . . *Hardin, Mo.*
Reeves, John Milton . . . . . *Anderson, Ind.*
Riley, George Lyne . . . . . *Henderson, Ky.*
Robertson, Sayle . . . . . *Grant City, Mo.*
Rountree, Newton Marshall . . . . . *Springfield, Mo.*
Runge, Charles Adelbert . . . . . *Kirkwood, Mo.*
Ruoff, Carl Matthews . . . . . *Hannibal, Mo.*
Russell, Richard . . . . . *Mineral, Kan.*
Sample, Truman George . . . . . *Farmington, Mo.*
Sapper, Ferdinand Eugene . . . . . *Galveston, Tex.*
Schaeffer, Ammon Daniel . . . . . *Springfield, Mo.*
Schmid, Dudley Charles . . . . . *Sedalia, Mo.*
Schmidt, Karl August . . . . . *Springfield, Mo.*
Schwarz, Herbert Grumbach . . . . . *Syracuse, N. Y.*
Simmerman, James Raymond . . . . . *Virginia, Ill.*
Stuart, Samuel Henry . . . . . *Rolla, Mo.*

Teller, Kedzie....................*Riverside, Ill.*
Teter, William Earl................*Bunker Hill, Ill.*
Tevis, Charles Cyrus...............*Holden, Mo.*
Thomas, Burns......................*St. Joseph, Mo.*
Thompson, Thomas Moffett...........*Goodland, Kan.*
Thomy, Lawrence....................*St. Louis, Mo.*
Torrence, Edward James.............*St. Louis, Mo.*
Turner, William Archibald..........*Kansas City, Mo.*
Updike, Donald Foster..............*Plainfield, N. J.*
Walling, William Henry.............*Dayton, Wyo.*
Walsh, David Francis...............*St. Louis, Mo.*
Watkins, Marion Whitfield..........*Memphis, Tenn.*
Webster, Vance Herschel............*Anderson, Ind.*
Weigel, Melvin Powell..............*Fredericktown, Mo.*
Weimer, Walter Henry...............*Girard, Kan.*
Wells, Harry.......................*Licking, Mo.*
Wendell, Everett John..............*Peoria, Ill.*
Westgard, James Arne...............*New York City, N. Y.*
Whitted, Robert Morris.............*Goodland, Kan.*
Wilkerson, Augustus Benton.........*Aurora, Mo.*
Williams, Miller...................*Jackson, Mo.*
Wilmesherr, Charlie Frank..........*Cuba, Mo.*
Wilson, Edgar Mark.................*Caney, Kan.*
Wix, Oscar Lee.....................*Harrington, Del.*
York, Samuel.......................*Kirksville, Mo.*
Zeller, George August..............*St. Louis, Mo.*
Zevallos, Robert Cavero............*Callao, Peru, S. A.*
Ziegler, William Clark.............*Providence, R. I.*
Zoller, Henry Eugene...............*Tulsa, Okla.*
Zook, Samuel Irwin.................*Buffalo, Kan.*

SPECIAL STUDENTS

Blankenship, David Alderson........*Beckley, W. Va.*
del Campo, Rene Cesar..............*Havana, Cuba.*
Coffeen, John Mitchell.............*Sheridan, Wyo.*
Collet, Charles John...............*Tulsa, Okla.*
Colville, George...................*Marceline, Mo.*
Cornwell, Benjamin Sedgely.........*St. Louis, Mo.*
Crawford, Howard Stanley...........*Rivera, Cal.*
Dent, Hazel Rena...................*Rolla, Mo.*
Edgar, Walter Thomas...............*Rolla, Mo.*
Elias, Zella.......................*Rolla, Mo.*
Ferer, Hyman.......................*St. Louis, Mo.*
Haberthier, Joseph John............*Wichita, Kan.*
Hodges, Horace Wilfred.............*Bridgeport, W. Va.*
Jones, Mabel Oma...................*Rolla, Mo.*

Kilgore, Sanford Walker. . . . . *Rolla, Mo.*
Kiskaddon, Charles Grahm. . . . . *Tulsa, Okla.*
Lee, Pao-Ho. . . . . *Chi-Yuan, Honan, China.*
Lenox, Jennie Lynn. . . . . *Rolla, Mo.*
Longacre, Myron Young, B. S., University of Missouri. . . . . *Pleasant Hill, Mo.*
Lyons, Joseph Jerry. . . . . *Springfield, Mo.*
MacCallum, John Seaver. . . . . *Joplin, Mo.*
McClurken, Russell Craig. . . . . *St. Louis, Mo.*
Mitchell, Homer Edward. . . . . *Rolla, Mo.*
Otten, Charles Victor. . . . . *Iola, Kan.*
Parker, Robert Lee. . . . . *Rolla, Mo.*
Rigby, John Herbert. . . . . *Meeker, Colo.*
Righthouse, James Shelby. . . . . *Iola, Kan.*
Sherwood, Ruth Green. . . . . *Kansas City, Mo.*
Stevens, Hoyt. . . . . *Webster Groves, Mo.*
Taulbee, Kelly Lyons. . . . . *Joplin, Mo.*
Tedford, Donald Samuel. . . . . *Diamond, Mo.*
Tragitt, Elizabeth Weedon . . . . *Rolla, Mo.*
Turner, Basil Harold. . . . . *St. Louis, Mo.*
Wagner, Louis Paul. . . . . *St. Louis, Mo.*
Walls, Cecil Albert. . . . . *McAlester, Okla.*
Werner, Walter August. . . . . *St. Louis, Mo.*
Whitney, Henry McLeod. . . . . *Kansas City, Mo.*

STUDENTS, FEDERAL BOARD FOR VOCATIONAL EDUCATION.

Aid, Kenneth. . . . . *Gallatin, Mo.*
Alton, William Joseph. . . . . *Columbia, Mo.*
Axton, Elmer Ray. . . . . *Hoyt, Colo.*
Bisch, Felix Grover. . . . . *Bonne Terre, Mo.*
Campbell, Chester Wilbur. . . . . *Sedalia, Mo.*
Cassil, Lawrence A. . . . . *Mountain Grove, Mo.*
Chapin, Elmer Fenton. . . . . *East St. Louis, Ill.*
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Coakley, John Leonard. . . . . *Kansas City, Kan.*
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Davis, Whitney Paul. . . . . *Kansas City, Mo.*
Dodson, George Clarence. . . . . *DeSoto, Mo.*
Engelage, Victor Frederick. . . . . *Syracuse, Mo.*
Evans, Otto Henry. . . . . *Meta, Mo.*
Evans, Owen Richard. . . . . *Granger, Mo.*
Farmer, Samuel Dewitt. . . . . *Galena, Kan.*
Frillman, Florian Louis. . . . . *St. Louis, Mo.*
Graham, Maurice Parish. . . . . *Sedalia, Mo.*
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Hollar, Percy Alvin. . . . . *Topeka, Kan.*

Howard, Max Raymond . . . . *Springfield, Mo.*
Huckins, Julian Greenway . . . . *Kirkwood, Mo.*
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Kratz, Francis Oliver . . . . *Iola, Kan.*
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Lapee, Roland Joseph . . . . *Sullivan, Mo.*
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Neuwirth, Alois George . . . . *St. Louis, Mo.*
O'Hara, Samuel Burl . . . . *Rosendale, Mo.*
Owen, Cassie . . . . *Gamble Mines, Ala.*
Owens, Irvin King . . . . *St. Louis, Mo.*
Riddle, John . . . . *Marion, Kan.*
Sanders, James Lewis . . . . *Doniphan, Mo.*
Siegle, William . . . . *St. Louis, Mo.*
Smith, Elwood Temple . . . . *Kansas City, Mo.*
Southern, Christopher . . . . *Kansas City, Mo.*
Stuerman, Harold Arthur . . . . *St. Louis, Mo.*
Sullivan, Robert . . . . *St. Louis, Mo.*
Taulbee, Kelly Lyons . . . . *Joplin, Mo.*
Thompson, William Elmer . . . . *Corning, Kan.*
Todd, Robert Rockford . . . . *Kansas City, Mo.*
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Weldon, Elzie Bryan . . . . *Fremont, Mo.*
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Wynn, Clarence Marion . . . . *Rolla, Mo.*
Yeager, Robert Lee . . . . *Joplin, Mo.*
Zink, Robert Earl . . . . *Independence, Mo.*
Zogg, Martin Flarian . . . . *Granby, Mo.*
Zook, Samuel Irwin . . . . *Buffalo, Kan.*

SUMMARY 1919-1920

Summer School, 1919		96
Fall and Winter Terms:		
Graduates		21
Class of 1920:		
Mine Engineering	29	
Metallurgy	10	
Civil Engineering	11	
General Science	3	
Mechanical Engineering	1	
Chemical Engineering	5	59
Class of 1921:		
Mine Engineering	46	
Metallurgy	7	
Civil Engineering	3	
General Science	3	
Electrical Engineering	3	
Chemical Engineering	8	70
Class of 1922:		
Mine Engineering	50	
Metallurgy	11	
Civil Engineering	6	
General Science	3	
Mechanical Engineering	4	
Electrical Engineering	2	
Chemical Engineering	10	86
Class of 1923		134
Specials		37
Federal Board Students:		
Collegiate	9	
Vocational	41	50
Total		553
Counted twice		92
Net		461

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Volume Thirteen Number Two

Catalogue 1920-21

SCHOOL OF MINES AND METALLURGY

UNIVERSITY OF MISSOURI

BULLETIN

MARCH, 1921

ROLLA, MISSOURI

Entered as second-class matter January 7, 1909, at the Post Office at Rolla, Missouri, under the Act of July 18, 1894. Issued Quarterly.

Fiftieth Annual Catalogue

SCHOOL *of* MINES *and* METALLURGY

UNIVERSITY *of* MISSOURI

ROLLA, MISSOURI

1921

CALENDAR, 1921

JANUARY TO DECEMBER

January

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

February

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

March

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

April

S	M	T	W	T	F
					1
3	4	5	6	7	8
10	11	12	13	14	15
17	18	19	20	21	22
24	25	26	27	28	29

May

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August

S	M	T	W	T	F
	1	2	3	4	5
7	8	9	10	11	12
14	15	16	17	18	19
21	22	23	24	25	26
28	29	30	31		

September

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

October

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						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

November

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

December

S	M	T	W	T	F
				1	2
4	5	6	7	8	9
11	12	13	14	15	16
18	19	20	21	22	23
25	26	27	28	29	30

CALENDAR, 1922

JANUARY TO DECEMBER

January

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

S	M	T	W	T	F
2	3	4	5	6	7
9	10	11	12	13	14
16	17	18	19	20	21
23	24	25	26	27	28
30					

May

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

June

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

July

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August

S	M	T	W	T	F
		1	2	3	4
6	7	8	9	10	11
13	14	15	16	17	18
20	21	22	23	24	25
27	28	29	30	31	

September

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

November

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December

S	M	T	W	T	F
					1
3	4	5	6	7	8
10	11	12	13	14	15
17	18	19	20	21	22
24	25	26	27	28	29
31					

CAMPUS VIEW

JACKLING GYMNASIUM

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CALENDAR

1921

WINTER TERM

January 3	Monday, Registration.
February 22	Tuesday, Washington's Birthday, holiday.
April 29	Friday, Commencement Day.

1921

SPRING-SUMMER TERM

April 30	Saturday, Registration.
June 25	Friday, First half term ends; second half term begins.
July 4	Monday, Independence Day, holiday.
August 19	Friday, Spring-Summer term ends.

1921

FALL TERM

August 29	Monday, Entrance Examinations.
August 30, 31	Tuesday, Wednesday, Registration.
September 1	Thursday, Classes begin.
November 24, 25, 26	Thursday, Friday, Saturday, Thanksgiving holidays.
December 21	Wednesday noon, Christmas holidays begin.

1922

WINTER TERM

January 2	Monday, Registration.
February 22	Wednesday, Washington's Birthday, holiday.
April 28	Friday, Commencement Day.

1922

SPRING-SUMMER TERM

April 29	Saturday, Registration.
June 14	Wednesday, First half term ends; second half term begins.
July 4	Tuesday, Independence Day, holiday.
August 12	Saturday, Spring-Summer term ends.

BOARD OF CURATORS

With dates of original appointments.

TERM EXPIRES JANUARY 1, 1921

John H. Bradley, 1915 . . . . *Kennett*
H. B. McDaniel, 1915 . . . . *Springfield*

TERM EXPIRES JANUARY 1, 1923

G. E. Muns, 1917 . . . . *Montgomery City*
P. E. Burton, 1920 . . . . *Joplin*
Milton Tootle, Jr., 1917 . . . . *St. Joseph*

TERM EXPIRES JANUARY 1, 1925

S. L. Baysinger, 1907 . . . . *Rolla*
H. J. Blanton, 1919 . . . . *Paris*
James E. Goodrich, 1919 . . . . *Kansas City*

TERM EXPIRES JANUARY 1, 1927

E. Lansing Ray, 1921 . . . . *St. Louis*

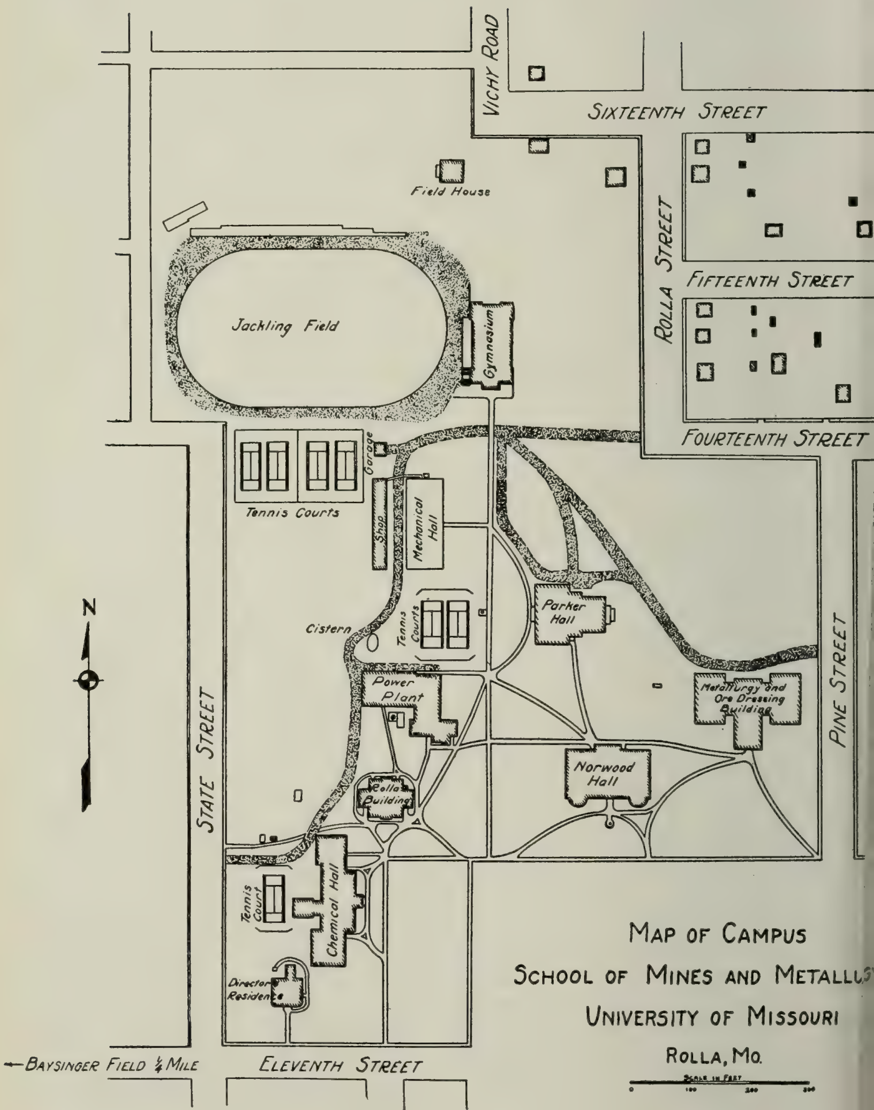
OFFICERS OF THE BOARD

. . . . *President*
James E. Goodrich . . . . *Vice-President*
Leslie Cowan . . . . *Secretary*
R. B. Price . . . . *Treasurer*

THE EXECUTIVE COMMITTEE

Of the School of Mines and Metallurgy

S. L. Baysinger, Chairman . . . . *Rolla*
H. B. McDaniel . . . . *Springfield*
G. E. Muns . . . . *Montgomery City*
Edward Kahlbaum, Secretary . . . . *Rolla*
C. M. Knapp, Treasurer . . . . *Rolla*



Vichy Road
Sixteenth Street
Field House
Rolla Street
Fifteenth Street
Jackling Field
Gymnasium
Fourteenth Street
Garage
Tennis Courts
Shop
Mechanical Hall
N
Cistern
Tennis Courts
Parker Hall
Pine Street
Power Plant
Metallurgy and Ore Dressing Building
State Street
Norwood Hall
Rolla Building
Tennis Court
Chemical Hall
Director's Residence
← Baysinger Field ¼ Mile
Eleventh Street
Map of Campus
School of Mines and Metallu
University of Missouri
Rolla, Mo.
Scale in Feet

FACULTY

ALBERT ROSS HILL, A. B., Ph. D., LL. D.,
President of the University.

CHARLES HERMAN FULTON, E. M., Sc. D.,
Director.

AUSTIN LEE McRAE, B. S., Sc. D.,
Emeritus Professor of Physics and Ex-Director.

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Professor of Civil Engineering.

GEORGE REINALD DEAN, B. S., C. E.,
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CARROLL RALPH FORBES, B. S., E. M.,
Professor of Mining.

JOSEPH WAYNE BARLEY, A. B., A. M., Ph. D.,
Professor of English and Modern Languages.

HAROLD LESLIE WHEELER, A. B., B. L. S.,
Librarian.

WILLIAM DeGARMO TURNER, B. S., Ph. D.,
Professor of Chemistry.

LEON ELMER WOODMAN, A. B., A. M., Ph. D.,
Professor of Physics.

CHARLES YANCY CLAYTON, B. S., Met. E.,
Professor of Metallurgy.

CHARLES LAURENCE DAKE, A. B., A. M. Ph. D.,
Professor of Geology and Mineralogy.
(Absent on leave, 1920-21).

CHARLES EDWARD COOKE, Topographic Eng., U. S. G. S.,
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HOWARD LOUIS PECKHAM, First Lieutenant, Corps of Engineers, U. S. Army.
Professor of Military Science and Tactics.

LEON ELLIS GARRETT, B. S.,
Professor of Mathematics.

FRANK EDWARD DENNIE, B. S.,
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HENRY HORTON ARMSBY, B. S., C. E.,
Associate Professor of Civil Engineering.

HOWARD LeROY DUNLAP, B. S., A. M.,
Associate Professor of Chemistry.

FREDERICK WILLIAM SHAW, M. D.,
Associate Professor of Hygiene and Student Health Adviser.

HARRY EDMUND BILGER, Ph. B., B. S. in C. E., M. S.,
Associate Professor of Highway Engineering.

JOSEPH HENRY BOWEN, Graduate, Miller School, Virginia,
Assistant Professor of Shop Work.

FLOYD HILL FRAME, A. B.,
Assistant Professor of Electrical Engineering.

EUGENE LEE JOHNSON, Ph. B., LL. B.,
Assistant Professor of English and Secretary to the Faculty.

GARRETT A. MUILENBURG, A. B., M. S.,
Assistant Professor of Geology and Mineralogy.
In charge of department, 1920-21.

JOSEPH RAMON GUITERAS, E. M.,
Assistant Professor of Geology.

ROBERT LEE RHOADS, B. S., M. E.,
Assistant Professor of Mechanical Engineering.

CLAIR VICTOR MANN, B. S.,
Assistant Professor of Drawing.

JOSIAH BRIDGE, A. B., M. S.,
Assistant Professor of Geology.

RYLAND FLETCHER RATLIFF, A. B., A. M.,
Assistant Professor of Physics.

MARTIN HARMON THORNBERRY, B. S., Met. E.,
Research Metallurgist, Experiment Station.

CLARENCE EDWARD BARDSLEY, B. S.,
Assistant Professor of Topographic Engineering.

WARREN SCOTT BOYCE, A. M., Ph. D.,
Assistant Professor of Economics.

VAN BUREN HINSCH, B. S.,
Instructor in Mathematics.

JOSEPH HENRY UNDERWOOD,
Instructor in Forge Shop.

ARTHUR SCOTT, Master Sergeant, U. S. Army,
Instructor in Military Science and Tactics.

THOMAS MELLOR BAINS, E. M.,
Instructor in Metallurgy.

RALPH VINCENT PRITCHARD, B. S.,
Instructor in Mathematics.

JOE BEATY BUTLER, B. S.,
Instructor in Civil Engineering.

OSCAR ADAM HENNING, A. B., A. M.,
Instructor in German.

PIERRE CELESTIN CAMBIAIRE, A. B., Ph. B.,
Instructor in Spanish and French.

KARL KENNETH KERSHNER, B. S., M. S.,
Instructor in Chemistry.

EDWARD HAROLD WOOLRYCH,
Instructor in Drawing.

VICTOR KOPPLE FISCHLOWITZ, B. S.,
Instructor in Chemistry.

ROGER McCUNE, B. S.,
Assistant Physical Director.

EDWARD MELVILLE PALMER, Staff Sergeant, U. S. Army,
Instructor in Military Science and Tactics.

WILLARD BARTLETT BREWER, Topographer U. S. G. S.,
Instructor in Topographic Engineering.

THADDEUS THORNDIKE RANNEY, Topographer, U. S. G. S.
Instructor in Topographic Engineering.

MARION SMITH BADOLLET, B. S.,
Assistant in Chemistry.

BARNEY NUDELMAN, B. S.,
Assistant in Chemistry.

WILLIAM WALBRIDGE WEIGEL, B. S.,
Assistant in Mining.

LEWIS ELY DAVIDSON, B. S.,
Assistant in Geology.

SAMUEL HORACE LLOYD, JR., A. B.,
Assistant in English.

OTHER OFFICERS

EDWARD KAHLBAUM,
Business Manager.

ROBERT RICHMOND DICKERSON,
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ZELLA ELIAS,
Secretary to the Director.

MARGUERITE IRISH NORVILLE, Graduate St. Louis Library School,
Assistant Librarian.

NINA EDITH ENGLISH, Graduate St. Louis Library School,
Cataloguer, Library.

NANCY HARRISON,
Assistant in Library.

ELIZABETH MONTGOMERY,
Stenographer.

RUTH FLETCHER STEVENS,
Stenographer.

EVA MAY UNDERWOOD,
Stenographer.

MILDRED SHAPIRO FISCHLOWITZ,
Stenographer.

STUDENT ASSISTANTS

Ernest Sterling Wheeler[2]	Chemistry
Huston Taylor[2]	Chemistry
Ernest Wayne Rembert[2]	Chemistry
William Prescott Gatts[1]	Chemistry
Jules Philip Colbert[2]	Civil Engineering
Henry Eugene Zoller[2]	Civil Engineering
Edwin Gilbert Machin[1]	Civil Engineering
Walter August Werner[1]	Civil Engineering
Henry Charles Loesche[2]	Drawing
Ray Alexander Lindgren[1]	Drawing
Philip LeRoy Blake[1]	Drawing
Guy Robert Scott[1]	Drawing
Muir Luken Frey[2]	English
Andrew Devereux[1]	English
Samuel Horace Lloyd, Jr.[1]	English
Lewis Ely Davidson[1]	Geology
William Ferdinand Netzeband[2]	Geology
Charles James Millar[2]	Hygiene
Percy Grant Forman[1]	Library
Homer Lakirby Leonard[2]	Library
Raymond Edward Murphy[2]	Library
William Lincoln Stewart, Jr.[1]	Mathematics
Chester Wilber Campbell[1]	Mechanical Engineering
Wayman Crow[2]	Metallurgy
Donald Foster Updike[1]	Metallurgy
Henry William Hurst[1]	Metallurgy
Richard Love Johnson[2]	Metallurgy
Joseph Herman Rohloff[1]	Metallurgy
Harold Leland Bailey[1]	Mining
Richard John Stroup[1]	Mining
Kenneth Robert Teis[1]	Mining
Harry Harvey Kessler[1]	Physical Training
Fred Pope White[1]	Physical Training
William Weeks Bolt[1]	Physical Training
John Pemberton Gordon[2]	Physical Training
John Leo Bulger[2]	Physical Training
Daniel Elijah Huffman, Jr[2]	Physics
Albert Louis Ackers[2]	Vocational
Earl McKinley Guy[1]	Vocational
William Weaver Keeler[1]	Vocational
James Ewart Jones[1]	Vocational
Edward James Torrence[2]	Director's Office

[1]Serving one term. [2]Serving two terms.

FACULTY COMMITTEES

Registrar
PROFESSOR DEAN

Secretary of the Faculty
ASSISTANT PROFESSOR JOHNSON

Committee on Policy
FULTON, DEAN, BARLEY, FORBES, HARRIS, TURNER, WOODMAN, CLAYTON, MUILENBURG, RHOADS, MANN, BOYCE, COOKE, WHEELER

Committee on Credits
DEAN, BARLEY, TURNER, HENNING, PRITCHARD

Committee on Student Schedules
DEAN, ARMSBY, FORBES

Committee on Discipline
BARLEY, FORBES, HARRIS, GARRETT

Committee on Curricula and Study Schedules
FORBES, CLAYTON, ARMSBY, FRAME, RATLIFFE

Committee on Graduate Students
TURNER, HARRIS, CLAYTON, MANN

Committee on Athletics and Physical Education
DENNIE, WOODMAN, GUITERAS, SHAW

Committee on Military Drill
PECKHAM, RHOADS, BAINS

Committee on Vocational Students
COOKE, BARDSLEY, WOOLRYCH

Committee on Publications
BARLEY, WHEELER, DUNLAP

Committee on Student Activities
ARMSBY, CAMBIAIRE, HINSCH, BRIDGE

ESTABLISHMENT AND STATUTES OF MISSOURI APPLYING TO THE SCHOOL OF MINES

The University of Missouri was established by an act of the General Assembly of the State of Missouri, approved February 11, 1839, two days after the act establishing the public school system of the state was approved.

The University was located at Columbia, Boone County, June 24, 1839. The cornerstone of the main building was laid July 4, 1840. The spring following, April 14, 1841, instruction in academic courses was begun. Women were first admitted to the University in 1869. The first class, consisting of two members, was graduated in 1843.

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College at Columbia and a School of Mines and Metallurgy in Southeast Missouri.

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The first class of three members was graduated in 1874.

Extracts from Revised Statutes of Missouri, 1919.

Sec. 11523. Corporate Name and Powers—Eminent Domain.—The university is hereby incorporated and created a body politic, and shall be known by the name of "The curators of the University of Missouri," and by that name shall have perpetual succession, power to sue and be sued, complain and defend in all courts; to make and use a common seal, and to alter the same at pleasure; to take, purchase and to sell, convey and otherwise dispose of lands and chattels; to condemn and appropriate real estate or other property, or any interest therein, for any public purpose within the scope of its organization, in the same manner and with like effect as is provided in chapter 13, article II of the Revised Statutes of 1919: Provided, that if the curators so elect, no assessment of damages or compensation under this article shall be payable, and no execution shall issue before the expiration of sixty days after the adjournment of the next regular session of the legislature held after such assessment is made, but the same shall bear interest at the rate of six per cent. per annum from its date until paid; and provided further, that the curators may, at any time, elect to abandon the proposed appropriation of property by an instrument of writing to that effect, to be filed with the clerk of the court and entered on the minutes of the court, and as to so much as is thus abandoned, the assessment of damages or compensation shall be void: Provided, that the curators shall not have power to sell or convey any land contained within the university campus.

Sec. 11524. Curators, Number of and How Appointed.—The Board of Curators of the University of the State of Missouri shall hereafter consist of nine members, who shall be appointed by the governor, by and with the advice

and consent of the senate: Provided, that not more than one person shall be appointed upon said board from the same congressional district, and no person shall be appointed a curator who shall not be a citizen of the United States, and who shall not have been a resident of the State of Missouri two years next prior to his appointment. Not more than five curators shall belong to any one political party.

Sec. 11525. The Term of Service—Classification—Compensation.—The term of service of the curators shall be six years, the terms of three expiring every two years, the first expiration occurring on the first day of January, 1911, and succeeding expirations of three members every two years thereafter. Said curators, while attending the meetings of the board, shall receive their actual expenses, which shall be paid out of the ordinary revenues of the university.

Sec. 11526. Executive Board—Executive Committee of School of Mines—Duties—Compensation.—The board of curators shall appoint annually three of their number to act as an Executive Board, who shall meet each month for the purpose of auditing claims and attending to such other business as may be intrusted to them by the Board of Curators, not inconsistent with this article. The members of the Executive Board shall receive five dollars per day for each day they shall attend the monthly meetings, together with their actual expenses, to be paid as the expenses of the curators are paid. Said Executive Board shall be subject to change or removal at pleasure of the Board of Curators. The Board of Curators shall also appoint annually three of their number to act as an Executive Committee of the School of Mines and Metallurgy, with like powers and compensation as those of the Executive Board at Columbia. Said Executive Committee shall also be subject to change or removal at pleasure of the Board of Curators.

Sec. 11562. College of Agriculture and School of Mines Established.—There is hereby established a College of Agriculture at Columbia and a School of Mines and Metallurgy at Rolla, provided for by the grant of the congress of the United States, as distinct departments of the University of the State of Missouri.

Sec. 11563. Object of These Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life.

Sec. 11564. Academic Course of Study, Etc.—That the obligation of the State to the general government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the University of the State of Missouri shall prescribe and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of a bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof.

Sec. 11570. Right to Confer Degrees.—The College of Agriculture and the School of Mines and Metallurgy shall have power to confer degrees suitable to their designs and courses of study; and the School of Mines and Metallurgy shall provide courses for, and shall confer the bachelor of science and professional degrees in mining engineering, in metallurgy, in mechanical engineering, in electrical engineering, in chemical engineering, in civil engineering and the degrees of bachelor and master of science in general science.

ENDOWMENT AND MAINTENANCE

1. LAND GRANT.—The proceeds from the sale of 275,000 acres of land granted to Missouri by Act of Congress of July 2, 1862. Most of this land has been sold and the sum invested in State Certificates of Indebtedness, yielding 5 per cent interest, and in municipal and drainage district bonds. The School of Mines receives one-fourth of this income, amounting to $4,588.52 annually. (See R. S. 1909, Sec. 11161, and Session Acts, 1911, p. 415.)

2. MORRILL BILL.—An annual appropriation of $50,000 by Act of Congress, approved August 30, 1890. One-sixteenth of this amount is by law appropriated to Lincoln Institute and one-fourth of the remainder, amounting to $11,718.75, to the School of Mines. (See R. S. 1909, Sec. 11171.)

3. SEMINARY FUND.—The proceeds from the sale of land donated to the School of Mines is invested in a State Certificate of Indebtedness of $2,000. The interest on this certificate amounts to $100 annually. (See R. S. 1909, Sec. 11161.)

4. DIRECT TAX ENDOWMENT.—In 1891 the Government returned to the various states the sums collected from its citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23. The Thirty-sixth General Assembly established this as a permanent endowment to the University and School of Mines. This endowment is invested in a State Certificate of Indebtedness bearing 5 per cent interest. The School of Mines receives one-fifth of this sum, amounting to $6,469.58. (See R. S. 1909, Sec. 11161.)

5. Interest on money derived from the sale of University lands invested in bonds: One-fifth to the School of Mines, amounting annually to $215.00.

6. The funds for the maintenance of the School of Mines are appropriated biennially by the State Legislature.

LOCATION, BUILDINGS AND GROUNDS

LOCATION

The School of Mines and Metallurgy is located at Rolla, Phelps County, on the St. Louis and San Francisco Railroad, one hundred and ten miles southwest of St. Louis.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above sea level, and has an agreeable and notably healthful climate. Its position on a transcontinental railway system makes it readily accessible.

The school is located convenient to the important mining districts of the state, the Southeast Missouri lead district on the one hand, and the Southwest Missouri, Kansas-Oklahoma zinc district on the other. The great oil fields of the southwest are readily accessible, and the school is in close touch with this industry. The location offers exceptional facilities for mining, ore dressing, metallurgy and geology. Missouri stands first in the production of lead, and is the center of an important smelting industry. The great zinc smelters of the Mississippi Valley are located within easy reach. The mineral and metallurgical industries centering in St. Louis, such as clay and brick, cement, alumina, chemical manufactures, lead and zinc smelting, afford excellent facilities for close range study.

The Mississippi Valley Experiment Station of the United States Bureau of Mines has its laboratories in the Metallurgical Building of the School of Mines. The field of this station is the lead and zinc industry of the Mississippi Valley. Through the Experiment Station, with which the State Mining Experiment Station co-operates, the school is brought into intimate contact with the great mineral industry of the Mississippi Valley.

BUILDINGS AND GROUNDS

Rolla Building.—The Rolla Building is the oldest building on the campus. It was built originally by the City of Rolla for a high school, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It now houses the Missouri Bureau of Geology and Mines (Missouri Geological Survey), and contains the library, laboratories drafting rooms, offices and geological collections of the Survey. It is a brick structure ninety feet by sixty feet, three stories and basement high.

Chemical Hall.—This building is used by the Department of Chemistry. The main portion of the building was erected in 1885. Two wings and a second story were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five by sixty feet and one story high. The stock room, twenty-eight feet wide by forty-four feet long, and two stories high, was erected in 1915. During the present year the basement of the south wing was remodeled into a modern laboratory for physical chemistry.

Power Plant.—The Power Plant Building was erected in 1895. It is a tile-roof, press-brick structure built in two parts, one containing offices and laboratories, and the other boiler room, engine room and mechanical engineering laboratory. The boiler room was enlarged in 1909.

Mechanical Hall.—This building was erected in 1901. It is a two-story brick building one hundred fifty feet by sixty feet, and contains the shops of the institution. The first floor is devoted to forge shop, machine shop, stock and tool rooms; the second floor to the wood shop, lecture rooms and drafting room.

Norwood Hall.—This is the main building of the School of Mines and was completed in 1903. It houses the departments of physics, electrical engineering, mining, geology, civil engineering, English and mathematics. It is a three-story and basement press-brick, stone-trimmed structure.

Ore Dressing and Metallurgy Building.—This building, completed in 1911, is used by the Department of Metallurgy, and at present also houses the Mississippi Valley Experiment Station of the United States Bureau of Mines. It is a three-story, gray, press-brick building with a basement and two large one-story wings, and contains over twenty-five thousand feet of floor space.

Parker Hall.—Parker Hall is the Administration Building. It is a fire-proof, two-story, gray, press-brick building with a high basement. The main portion of the building is one hundred two by fifty-five feet and the wing is fifty-eight by sixty feet. The library occupies the second floor, the administrative offices and faculty rooms the first floor, and in the wing is the auditorium seating six hundred fifty persons. This auditorium is provided with stage and with moving picture machine. In the basement of the building are located the materials testing laboratories.

The Jackling Gymnasium.—This building was completed in 1915. It is located at the north end of the campus adjoining Jackling Field. The building occupies an area seventy-two feet wide and one hundred twenty-seven feet long and is built of dark red, rough brick with terra-cotta trimmings. The interior is of fire-proof construction. It contains a swimming pool twenty feet by

sixty feet in size. The gymnasium is modern in every way. It contains all the necessary appliances for physical training. In the gallery of the gymnasium is a running track of twenty-six laps to the mile.

Grounds and Athletic Field.—The campus of the School of Mines is situated in the highest part of the City of Rolla and is thirty-two acres in extent. It contains beautiful lawns, groves of native oak and maple shade trees. The Jackling Athletic Field has a baseball diamond, a football gridiron, and a four hundred forty yard running track and tennis courts. The golf links of the school, containing approximately eighty acres, are situated just west of the city limits and within four blocks of the campus.

ADMISSION

Under the statutes, persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation.

Students are admitted in the following ways:

By Certificate.—Applicants who are graduates from accredited high schools will be admitted without examination, provided they present a certificate signed by the superintendent or principal showing that the applicant has to his credit fifteen units. Of these units three in English, one and one-half in Algebra, one in Plane Geometry are required.

Graduates of high schools who lack credit in the required units must pass an examination to make up such deficiency.

By Examination.—Applicants who are not graduates of high schools are required to pass examinations in fifteen units as outlined below, a unit being equivalent to a year's work in one subject as given in approved high schools.

By Advanced Standing.—Applicants may be admitted to advanced standing either upon examination in the subjects of the previous year or years or upon certificate from another institution of work accomplished which, in the estimation of the faculty, is equivalent to that completed here by the class into which entrance is sought. They must also before becoming candidates for degrees present evidence of the satisfactory completion of all entrance requirements into the Freshman Class. Every applicant must also present a letter of honorable dismissal from the school last attended.

As Special Students.—Mature applicants who have not the full number of entrance units may be admitted under the following provisions:

1. They must be at least twenty-one years of age.

2. They must show good reasons for not taking a regular course.

3. They must pass such examinations or other tests as shall demonstrate their fitness to pursue profitably all the subjects selected by them.

4. They shall not be candidates for a degree.

DEFINITION OF ENTRANCE UNITS

English.—The four units that may be offered include grammar, composition and rhetoric, literature and history of English and American literature.

Algebra.—The two units that may be offered include the fundamental operations of algebra, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and coefficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomical theorem, ratio and proportion, and logarithms.

Plane Geometry.—The work in plane geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of algebra to geometry, and of geometry to algebra and arithmetic.

Solid Geometry.—The work in solid geometry must cover a half year's course in any good text.

Trigonometry.—One year's work in any good high school text. This work will not be accepted for advanced standing.

History.—One year's work in ancient, mediaeval, modern, English or American history.

Other Units.—A full year's course as offered in an accredited school will be accepted as a unit.

Maximum and Minimum Number of Units in Each Subject Accepted for Entrance.

Subject.	Min.	Max.
English	3	4
Algebra	1½	2
Plane Geometry	1	1
Solid Geometry	0	½
Trigonometry	0	1
Advanced Arithmetic	0	1
Commercial Arithmetic	0	1
History	0	4
American Government	0	1
Greek	0	2
Latin	0	2
French	0	2
German	0	2
Spanish	0	2
Agriculture	0	1
Biology	0	1
Botany	0	1
Chemistry	0	2
Physics	0	2
Physiology	0	1
Zoology	0	1
Physical Geography	0	1
Commercial Geography	0	1
Bookkeeping	0	2
Drawing	0	2
Economics	0	2
Manual Training	0	2
Psychology	0	1

ACCREDITED HIGH SCHOOLS

(1919-20) designates schools advanced to first class this year. T. T. designates Teacher-Training Schools. C. D. designates consolidated schools. (1) Designates schools that are members of the North Central Association.

Adrain T. T.
Albany T. T.
Anderson
Appleton City T. T.
Armstrong
Ash Grove
Aurora T. T.
Auxvasse C. D., T. T.
Ava T. T.
Barnard 1919-20
Bellflower 1919-20
Belton
[1]Bethany T. T.
Bevier
Bigelow C. D., 1919-20
Billings
Bismarck
Bloomfield
Blue Springs
Bolivar T. T.
Bonne Terre
Boonville T. T.
Bosworth
Bowling Green T. T.
Braymer
Breckenridge
Brookfield T. T.
Browning 1919-20
Brunswick T. T.
Bucklin
Buckner
Buffalo T. T.
Bunceton
Burlington Junction
Butler T. T.
Cabool
Cainesville
California T. T.
Callao
Cameron T. T.
Campbell T. T.
Canton T. T.
Cape Girardeau
Carl Junction 1919-20
[1]Carrollton T. T.
Carterville
[1]Carthage
Caruthersville
Cassville
Centralia T. T.
Chaffee
[1]Charleston T. T.
[1]Chillicothe T. T.
Chula
Clarence
Clarksburg 1919-20
[1]Clayton T. T.
Clifton Hill
Clinton T. T.
Coffey
Cole Camp
[1]Columbia
Concordia 1919-20
Corder
Craig
Crane
Dawn
Dearborn
Deepwater
DeKalb
Desloge
DeSoto T. T.

Dexter T. T.
Dixon
Doe Run 1919-20
Doniphan T. T.
Downing
Drexel
East Prairie
Edgerton
Edina T. T.
Eldon T. T.
Eldorado Springs T. T.
Ellington 1919-20
Elmo 1919-20
Elsberry
Elvins
Eminence 1919-20
Eolia C. D.
Esther
Eureka C. D.
Everton
[1]Excelsior Springs T. T.
Fairfax
Farmington
Fayette
[1]Ferguson
Festus
Flat River T. T.
Forest City 1919-20
Fornfelt
Forsyth
Frankford
[1]Fredericktown T. T.
[1]Fulton T. T.
Gallatin T. T.
Galt
Garden City
Gideon 1919-20
Gilliam 1919-20
Gilman City
Glasgow
Golden City
Gorin
Gower C. D.
Graham C. D.
Grain Valley 1919-20
Granby
Grant City T. T.
Green City T. T.
Greenfield T. T.
Green Ridge 1919-20
Greenville
Hale
Hamilton
[1]Hannibal
Hardin
[1]Harmony C. D., 1919-20 (Ravenwood P. O.)
Harrisonville T. T.
Hayti T. T.
Herculaneum
Hermann 1919-20
Hickman Mills C. D.
Higbee
[1]Higginsville T. T.
Holden T. T.
Holt 1919-20
Hopkins
Houston T. T.
Humansville
Hume C. D.
Huntsville T. T.
[1]Independence T. T.
Ironton T. T.
Jackson T. T.
Jameson C. D.
Jamesport
Jasper
[1]Jefferson City T. T.
[1]Joplin T. T.
Kahoka T. T.
Kansas City—
[1]Central
[1]Manual Training
[1]Northeast
[1]Westport
[1]Lincoln (colored)
Kearney 1919-20
[1]Kennett
Keytesville
King City T. T.
[1]Kirksville T. T.
[1]Kirkwood
Knobnoster
Knox City

LaBelle
Laclede
Laddonia
LaGrange
Lamar T. T.
Lamonte
Lancaster T. T.
LaPlata T. T.
Lathrop
Lawson
Leadwood
[1]Lebanon T. T.
Lees Summit T. T.
Lewistown C. D.
[1]Lexington T. T.
Liberal
Liberty T. T.
Linneus
Lockwood
Louisiana
Macon T. T.
Madison
Maitland
Malden
Mansfield 1919-20
[1]Maplewood
Marceline
Marionville
[1]Marshall T. T.
Marshfield T. T.
[1]Maryville
Maysville T. T.
Meadville
Memphis T. T.
[1]Mexico
Milan T. T.
Mindenmines C. D.
[1]Moberly T. T.
Monett T. T.
Monroe City T. T.
Montgomery City T. T.
Morehouse
Morley
Morrisville
Mound City
Mountain Grove T. T.
Mountain View 1919-20
Mt. Vernon
Neosho T. T.
[1]Nevada T. T.
New Franklin
New Hampton
New Haven
New London
New Madrid
New Point 1919-20
Norborne
Novelty T. T.
Oak Grove
Odessa
Oran 1919-20
Oregon
Orrick
Oceola T. T.
Otterville C. D.
Overland C. D.
Ozark
Palmyra T. T.
[1]Paris T. T.
Parma 1919-20
Pattonsburg
Peculiar 1919-20
Peirce City
Perry T. T.
Perryville T. T.
Piedmont
Pineville 1919-20
Platte City
Plattsburg T. T.
Pleasant Hill
Polo
[1]Poplar Bluff T. T.
Portageville
Potosi
Princeton T. T.
Purdin 1919-20
Puxico
Queen City T. T.
Ravenwood C. D. 1919-20
Raymore C. D.
Raytown C. D. 1919-20
Republic
Rich Hill
Richland

Richmond T. T.
Ridgeway T. T.
Rockingham C. D., 1919-20
(P. O. Hardin)
Rockport
Rocky Comfort
Rolla T. T.
St. Charles
Ste. Genevieve T. T.
St. James
St. Joseph—
[1]Benton
[1]Central
St. Louis—
[1]Central
[1]Cleveland
[1]McKinley
[1]Soldan
[1]Yeatman
[1]Sumner (colored)
Salem T. T.
Salisbury T. T.
Sarcoxie
[1]Savannah T. T.
Sedalia
Seneca
Seymour
[1]Shelbina T. T.
Shelbyville T. T.
Sheldon 1919-20
Sheridan
Sikeston T. T.
Skidmore
Slater T. T.
Smithville
[1]Springfield
Stanberry
Steelville
Stewartsville
Stockton
Sturgeon
Sullivan
Sweet Springs
[1]Tarkio T. T.
Thayer T. T.
Tina
Tipton
Trenton T. T.
Triplett
Troy T. T.
Union
Union Star
Unionville T. T.
University City
Urbana
[1]Vandalia T. T.
Versailles
Walnut Grove
Warrensburg
Warsaw T. T.
Washington T. T.
[1]Webb City T. T.
[1]Webster Groves
Wellington
[1]Wellston
Wellsville
Weston
Westboro C. D. 1919-20
[1]West Plains T. T.
Williamsville
Willow Springs
Windsor T. T.
Winona C. D.
Wyaconda C. D.

ACCREDITED PRIVATE SCHOOLS

Name.	*Address.*
Academy of Marionville College	Marionville
[1]Academy of Rockhurst College	Kansas City
Academy of Conception College	Conception
Cathedral High School	St. Joseph
[1]Country Day School	Kansas City
Academy of Chaminade College	Clayton
De LaSalle Academy	Kansas City
Iberia Academy	Iberia
[1]Kemper Military School	Boonville
Kendrick Catholic Boys' High School	St. Louis
Kidder Institute	Kidder
[1]Missouri Military Academy	Mexico
School of the Ozarks	Hollister
Rosetti-Kain High School	St. Louis
St. Vincent's High School	Perryville
[1]Wentworth Military Academy	Lexington

[1]Certificates will be accepted from high schools in other states which are affiliated with their respective state universities, provided these are of similar rank with the University of Missouri.

FEES AND EXPENSES

Tuition Fee.—Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after January 1, 1909, non-residents of Missouri who matriculate in any department of the university be required to pay a tuition fee of $20.00 per year."

Contingent Deposits.—A deposit of $15.00 is required from each student to cover the cost of extra supplies and damage to apparatus. This deposit must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Registration Fee.—By order of the Curators, a registration fee of $10.00 a term will be charged all students.

Laboratory Fees

Chemistry.

2	General Chemistry Laboratory	$5.00
4	General Chemistry Laboratory	5.00
6	Qualitative Analysis	10.00
8	Gravimetric Analysis	5.00
10	Volumetric Analysis	5.00

For each other laboratory course in Chemistry, a fee of $2.00 is charged, and in addition the student pays for special chemicals used in the particular course.

Civil Engineering.

102	Plane Surveying	3.00
104	Topographic Surveying	3.00
107	Railroad Surveying	2.00
108	Highway Engineering	3.00

Drawing.

211	Elementary Drawing	1.50
212	Descriptive Geometry	1.50
221	Advanced Mechanical Drawing	1.00
223	Machine Drawing	1.00
222	Topographical Drawing	1.00
1117	Oil Field Engineering Drawing	1.00

Geology and Mineralogy.		
501	Crystallography	1.00
503	Mineralogy	5.00
505	General Engineering Mineralogy	2.00
513	General Geology	2.00
530	Lithology	2.00
532	Petrography	3.00
534	Petrography	2.00
543	Field Geology	5.00
545	Oil and Gas	2.00
606	Materials Laboratory	2.50
Mechanical Engineering.		
701	Forge Shop	2.50
706	Forge and Foundry	2.50
712	Elementary Heat Power Apparatus	2.00
722	Advanced Machine Design	2.00
770 & 771	Power Plants	4.00
720	Compressed Air	2.00
702	Pattern Shop and Foundry	2.50
703	Machine Shop and Acetylene Welding	5.00
713	Internal Combustion Engines	2.50
Metallurgy and Ore Dressing.		
802	Fire Assaying	18.00
804	Fire Assaying	10.00
808	General Metallurgy Laboratory	4.00
812	Non-Ferrous Metallurgy	3.00
814	Non-Ferrous Metallurgy	3.00
822	Electrometallurgy Laboratory	2.50
832	Ore Dressing Laboratory	2.00
834	Ore Dressing Laboratory	2.00
864	Alloys and Metallography	3.00
866	Alloys and Metallography	2.00
Mining.		
903	Mining Laboratory	2.50
901	Mine Surveying	1.00
Physics and Electrical Engineering.		
1001	Physics Laboratory	2.00
1003	Physics Laboratory	2.00
1051	Dynamo Laboratory	2.00
1053	Dynamo Laboratory	2.00
1056	Electrical Machinery Laboratory	2.00
1058	Electrical Machinery Laboratory	2.00
1054	Electric Transmission and Distribution	4.00
	Gymnasium and Athletic Fee, per term	$5.00
	Diploma Fee	5.00

A student who has to repeat a laboratory course will be charged a second fee for that course. For finishing an incomplete laboratory course, a prorated additional fee will be charged.

Total Expenses for Fees for Four-Year Courses According to Curriculum

	Resident.	Non-resident.
Mine Engineering	$264.75	$344.75
Metallurgical Engineering	262.75	342.75
Chemical Engineering	265.25	345.25
Civil Engineering	208.25	288.25
General Science	226.75	306.75
Mechanical Engineering	221.75	301.75
Electrical Engineering	224.75	304.75

The Senior inspection trip in Mining, Metallurgical and Chemical Engineering courses costs from $75.00 to $100.00.

Room rent costs from $8.00 to $15.00 per month.

Table board at the present time will cost about $30.00 a month.

RULES GOVERNING STUDENTS

The student is expected to pursue his studies with diligence, to attend classes regularly, to live morally and maintain good behavior. The removal of those who fail to meet these requirements is in the interest of the school. Students are under the direct supervision of the school only when on the campus, but they are responsible for their conduct wherever they may be.

Absences.—Any student who absents himself from any class during either of the two days immediately preceding or the two days succeeding any regular holiday or vacation term of the School of Mines, shall be reported to the Director and, unless he can offer a satisfactory explanation, the Director shall instruct the Registrar to record against him on his record card additional requirements in credit hours for graduation to the amount of not less than one, or more than six, hours for each offense.

A student shall have added to his requirements for graduation one credit hour for each total of seventeen absences during a term, or for a total of twenty-six absences during the fall and winter terms.

Minimum Requirement of Work.—Any student who fails to complete satisfactorily 10 credit hours of work per term will be dropped from the roll of the school.

System of Grading.—

E—Excellent	95-100%
S—Superior	85- 95%
M—Medium	75- 85%
I—Inferior	65- 75%
F—Failure, below	65%

CURRICULA AND DEGREES

Curricula Offered.—The School of Mines and Metallurgy offers the following curricula. The Roman numerals identify the curricula.

I. Mine Engineering.
II. Metallurgy.
III. Civil Engineering.
IV. General Science.
V. Mechanical Engineering.
VI. Electrical Engineering.
VII. Chemical Engineering.

The several courses of study are arranged to contain all the necessary fundamental sciences and language and the essential technical subjects in such order as to lead to a logical and coherent technical education. In recognition of the demand from the mineral industry and the engineering profession for some definite, specific technical training available on graduation, the Senior year of each curriculum offers definite options; for example, in Mine Engineering the student has a choice of the following options: (a) Metal Mining, (b) Coal Mining, (c) Mining Geology, (d) Petroleum Engineering. The other curricula also offer options, as described under the respective curricula. Preceding the work of the Senior year, the courses are largely fundamental, and all regular students are required to take full work in English, Physics, General Chemistry and Mathematics.

The General Science curriculum, IV, differs from the Engineering curricula in that it contains no applied science subjects, but pure science subjects only. It is directed toward giving an education either in geological science, or in chemical and physical science. The graduates from the course are fitted to pursue research work, or to enter the teaching profession in college work in physics, chemistry or geology.

The School of Mines and Metallurgy maintains extensive laboratories for practical instruction. The school has been in existence for fifty years and has acquired, especially in geology and mineralogy, metallurgy and mining, and chemistry, excellent collections and equipment. The surroundings of the school lend themselves well to field work in geology. The Mining Department operates an experimental mine, located within a short distance from the school campus. Every effort is made thoroughly to ground the students in the fundamental sciences, and to make the

technical instruction practical as well as scientific. The school keeps in close touch with the mining and metallurgical operations in the several mining districts of the state. All curricula, except that in General Science, IV, are the same in the Freshman year and differ but slightly in the Sophomore year. The student thus need not make a choice of special work until after being well started in his course.

The School Year.—The school year comprises three terms of sixteen weeks each, or forty-eight weeks during the year. It is divided into the fall term, the winter term and the spring-summer term. The curricula are based on the fall and winter terms, being completed normally in four years. The spring-summer term is intended to afford students an opportunity to shorten the normal four-year curriculum into three years by taking the work of two spring-summer terms. It also affords students deficient in certain subjects an opportunity to make up this deficiency during the summer. In order to preserve the continuity in curricula, the spring-summer term is divided into two halves of eight weeks each. In the first half, fall term subjects, and in the second half, winter term subjects are given. In each half of the spring-summer term the student will take but half the normal number of subjects, but with double the number of hours, as, for example, in the Freshman year in the winter term, English is given three times per week; in the spring-summer term it will be given six times per week.

Credit Hours Required for Graduation.—The number of credit hours required for graduation ranges from 185 to 197, dependent upon the curriculum pursued. This includes Military Science and Tactics.

Definition of a Credit Hour.—A credit hour is the credit obtained for satisfactorily passing a course of one hour in the classroom per week for sixteen weeks or one term. In computing the relation between laboratory and classroom hours, two laboratory hours are considered the equivalent of one classroom hour. This does not apply to Military Science and Tactics.

Physical Training and Military Science and Tactics.—Military Science and Tactics and Physical Training are required of all physically fit male students in the Freshman and Sophomore years. The satisfactory completion of a year of Military Science and Tactics entitles the student to six credit hours, or twelve hours' credit in the two years. For further information on military instruction and the Reserve Officers' Training Corps, refer to the section in the catalogue on "Military Science and Tactics."

Requirements in Practical Work.—Before receiving a degree in any engineering course, in addition to completing a curriculum as outlined, the student must have worked not less than twelve

weeks in the industry or line of work in which he is specializing. If he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some mine, mill or other industrial plant, or on any work designated by the department concerned. A regularly supervised inspection trip may be taken in place of this prescribed work, if offered by the department.

Suitable reports and satisfactory credentials are required on all the work described above. This work should be done during the summer following the Junior year, if possible.

Students in curricula I, II and VII are also required to take an inspection trip during the Senior year.

Degrees.—The degree of Bachelor of Science in Mine Engineering, Metallurgy, Civil Engineering, Mechanical Engineering, Electrical Engineering or Chemical Engineering will be conferred upon the candidate who has pursued the corresponding curriculum, and earned the requisite number of credit hours, and fulfilled the requirements in practical work. Though a student enter with advanced standing, the final year's work must be done in residence.

The degree of Master of Science in Mine Engineering, Metallurgy, Civil Engineering, Mechanical Engineering, Electrical Engineering or Chemical Engineering will be conferred upon the candidate who holds a Bachelor of Science degree, and who has completed in residence one year's graduate work to the satisfaction of the faculty, and who has submitted an acceptable thesis.

In the curriculum of General Science, IV, the degree of Bachelor of Science will be conferred, and correspondingly for post-graduate work, the degree of Master of Science.

The degree of Engineer of Mines, Metallurgical Engineer, Civil Engineer, Mechanical Engineer, Electrical Engineer or Chemical Engineer will be conferred upon a candidate who holds a degree of Bachelor of Science in any engineering curriculum, and who submits a satisfactory record of at least three years of professional experience in the work in which he applies for a degree. In addition to this he must submit a thesis satisfactory to the department within which his work naturally falls.

Graduate Curricula.—Graduate work is offered in mining, metallurgy, geology, chemistry and civil engineering. The work is elective, under the advice of the faculty.

Courses in Vocational Training. (VIII).—In co-operation with the Federal Board for Vocational Education, courses are offered in topographic engineering, highway engineering, and oil field engineering. These courses do not lead to a degree.

Thesis.—Seniors may elect to carry on a special investigation and embody the work in a thesis. The subject of the thesis must be approved by the head of the department most concerned not

later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses, whether undergraduate or graduate, must conform to the following specifications:

The finished thesis should be typewritten (or printed) on eight and one-half by eleven-inch paper, written on one side only. The paper should be strong linen, unruled and without marginal lines.

The thesis should be typewritten so as to have a margin all around of not less than one and one-half inches.

Thesis paper should not be punched with holes for staples.

Thesis, when submitted, should not be stapled, sewed, or bound in any manner, but should be on loose sheets, in order that all theses may be bound uniformly by the Library.

Drawings, tracings, blue prints, diagrams, statistical tables, etc., when on a single 8½x11-inch sheet, should allow a margin of at least 1½ inches on the inner (long) edge, for binding purposes. When on a larger sheet, requiring folding, large margin should be allowed on all sides, and drawings should not be folded, but submitted flat or rolled, in order that they may be properly folded and adjusted by the binder. It is suggested that students confer with the Librarian in regard to the preparation of drawings, diagrams, tracings, etc.

The thesis should have:

1. A title page, containing the subject of the thesis, the writer's name and the date. It should show the approval of the professor under whose direction the work has been done and should also state the degree for which the candidate is an applicant.
2. A table of contents.
3. A list of illustrations.
4. The body of the thesis, including illustrations.
5. A bibliography.
6. An index.
7. Original drawings or tracings.

All theses submitted by candidates for degrees become the property of the School of Mines and Metallurgy and may not be published without its approval.

Curricula.—The synopses of the several curricula follow below. The title of the course is descriptive of the work and the **number identifies the department** in which it is given. The convention of number is as follows:

Chemistry	1 - 99
Civil Engineering	100 - 199
Drawing	200 - 299
Economics	300 - 399
English and Modern Languages	400 - 499

Geology	500 - 599
Hygiene and Student Health	60 - 75[1]
Mathematics	600 - 649
Mechanical Engineering	700 - 799
Mechanics	650 - 699[2]
Metallurgy	800 - 899
Mining	900 - 999
Physics and Electrical Engineering	1000 - 1099
Vocational Training (Federal Board)	1100 - 1199
Military Science and Tactics	M
Physical Education	PE

[1]Represent numbers lent by Department of Chemistry.
[2]Represent numbers lent by Department of Mathematics.

FIRST YEAR

ALL CURRICULA.

Number.	Name of Course.	Hours per week. Lect.	Lab.	
	First Term:			
600	Plane and Spherical Trigonometry	5	0	
400	Rhetoric and Composition	3	0	
211	Elementary Drawing[1]	0	6	
102	Plane Surveying[1]	2	6	
1 and 2	General Chemistry	3	6	
M 1	Military Science and Tactics	2	1	
PE 1 and 2	Physical Training	1	1	
				26
	Second Term:			
601	Analytical Geometry	5	0	
401	Rhetoric and Composition	3	0	
212	Descriptive Geometry[1]	0	6	
3 and 6	General Chemistry	4	6	
701	Forge Shop[1] or	0	6	
104	Topographic Surveying[1]			
M 1	Military Science and Tactics	2	1	
PE 3	Physical Training	0	2	
	Special Lectures			26

[1]In the General Science Curriculum IV, Elementary Drawing 211 and Plane Surveying 102, are replaced by General Zoology 61-62 in the first term, and Descriptive Geometry 212 and Topographic Surveying 104, by General Botany 63-64 in the second term.

SECOND YEAR

CURRICULUM I, MINE ENGINEERING
CURRICULUM II, METALLURGY
CURRICULUM VII, CHEMICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
602	Calculus	4	0
420	English	3	0
1000 and 1001	Physics	4	6
503	Mineralogy	0	6
7	Analytical Chemistry	2	0
8	Gravimetric Analysis	0	6
M 2	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25 ½
	Second Term:		
603	Calculus	4	0
421	English	3	0
1002 and 1003	Physics	4	6
10	Volumetric Analysis	0	6
801 and 802	Assaying[1]	2	6
M 2	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25 ½

[1]Students taking the Coal Mining Option substitute for Assaying 801 and 802 the following: Fuel and Gas Analysis 34, and Advanced Mechanical Drawing 221. Students taking the Petroleum Engineering Option substitute for Assaying 801 and 802 the following: Organic Chemistry Aliphatic 21 and Organic Chemistry Laboratory 22.

Students in Curriculum VII, Chemical Engineering, substitute for Assaying 801 and 802 the following: Organic Chemistry Aliphatic 21 and Organic Chemistry Laboratory 22.

SECOND YEAR

CURRICULUM III, CIVIL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
602	Calculus	4	0
402, *or* 420, *or* 422	English	3	0
1000 and 1001	Physics	4	6
221	Advanced Mechanical Drawing	0	6
107	Railroad Surveying	2	6
M 2	Military Science and Tactics	2	1
PE 4	Physical Education	0	2
			25½
	Second Term:		
603	Calculus	4	0
421, *or* 423	English	3	0
1002 and 1003	Physics	4	6
651	Theoretical Mechanics	3	0
222	Civil Engineering Drawing	0	6
M 2	Military Science and Tactics	2	1
PE 4	Physical Education	0	2
			23½

SECOND YEAR

CURRICULUM IV, GENERAL SCIENCE

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
602	Calculus or	4	0
460	Elementary French	5	0
420	English	3	0
1000 and 1001	Physics	4	6
503	Mineralogy	0	6
7	Analytical Chemistry	2	0
8	Gravimetric Analysis	0	6
M 2	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25½
	Second Term:		
603	Calculus or	4	0
461	Scientific French	5	0
421	English	3	0
1002 and 1003	Physics	4	6
10	Volumetric Analysis	0	6
21	Organic Chemistry Aliphatic	2	0
22	Organic Chemistry Laboratory	0	6
M 2	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25½

SECOND YEAR

CURRICULUM V, MECHANICAL ENGINEERING
CURRICULUM VI, ELECTRICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
602	Calculus	4	0
402, *or* 420, *or* 422	English	3	0
1000 and 1001	Physics	4	6
221	Advanced Mechanical Drawing	0	6
702	Pattern Shop and Foundry	1	6
M2	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			24½
	Second Term:		
603	Calculus	4	0
402, *or* 421, *or* 423	English	3	0
1002 and 1003	Physics	4	6
651	Theoretical Mechanics	3	0
223	Machine Drawing	0	3
703	Machine Shop	0	6
M 2	Military Science and Tactics	2	1
PE	Physical Training	0	2
			25

THIRD YEAR

CURRICULUM I, MINE ENGINEERING

Number.	Name of Course.	Hours per week.		
		Lect.	Lab.	
	First Term:			
651	Theoretical Mechanics	3	0	
1050 and 1051	Elements of Electrical Engineering	3	3	
510	General Geology	3	0	
530	Lithology	0	3	
900 and 901	Mine and Railroad Surveying[1]	3	6	
903	Mining, Laboratory[1]	0	3	
				19½
	Second Term:			
652	Mechanics of Materials	3	0	
653	Materials Laboratory	0	3	
512	General Geology	3	0	
513	General Geology Laboratory	0	6	
807	Principles of Metallurgy[2]	3	0	
904	Mining[3]	4	0	
1052 and 1053	Elements of Electrical Engineering	3	3	
				22
	Summer:			
990	Work in Practice			

[1]Students taking the Petroleum Engineering Option omit Mining, Lab. 903 and substitute for Mine and Railroad Surveying 900 and 901 the following: Railroad Surveying 107.

Students taking the R. O. T. C. Option will substitute Military M 3 for Mine Surveying Laboratory 901, in the first term, and Military M 3 for General Geology Laboratory 513 in the second term.

[2]Students taking the Coal Mining Option or the Petroleum Engineering Option substitute for Principles of Metallurgy 807 the following: Hydraulics 131.

[3]Students taking the Petroleum Engineering Option substitute for Mining 904 the following: Oil Production Methods 920 and Fuel and Gas Analysis 34.

THIRD YEAR

CURRICULUM II, METALLURGY

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
1050 and 1051	Elements of Electrical Engineering.........	3	3
41 and 42.....	Physical Chemistry.....................	3	6
651...........	Theoretical Mechanics....................	3	0
805...........	Introductory Metallurgy..................	1	6
	Electives[1]............................	3	
			20½
	Second Term:		
807...........	Principles of Metallurgy..................	3	0
809...........	Metallurgy of Iron and Steel.............	3	0
43 and 44.....	Physical Chemistry......................	2	6
1052 and 1053.	Elements of Electrical Engineering.........	3	3
652...........	Mechanics of Materials...................	3	0
	Electives[2].............................	3	
			21½
	Summer:		
890...........	Work in Practice........................		

[1]Electives to be chosen from the following: 912, Principles of Mining; 403, Engineering English; M 3, Military.

[2]Electives to be chosen from the following: 810, Metallurgical Calculations; 653, Materials Laboratory; M 3, Military.

THIRD YEAR

CURRICULUM III, CIVIL ENGINEERING

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
	First Term[1]**:**		
652	Mechanics of Materials	3	0
653	Materials Laboratory	0	3
111	Masonry Construction	3	3
108	Highway Engineering	3	9
861	Metals in Engineering	2	0
403	Engineering English	2	0
			20½
	Second Term:		
112	Reinforced Concrete	3	6
121	Stresses	3	6
131	Hydraulics	3	3
514	General Geology	3	0
505	Mineralogy	0	3
			21
	Summer:		
190	Work in Practice		

[1]Students enrolled in the R. O. T. C. will replace the equivalent of 3 hours' work as scheduled by Military M 3.

THIRD YEAR

CURRICULUM IV, GENERAL SCIENCE

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
41 and 42	Physical Chemistry	3	6
863 and 864	Alloys and Metallography	2	6
450	Elementary German	5	0
	Electives	6	
			22
	Electives from the following subjects:		
23	Organic Chemistry Aromatic	4	..
24	Organic Chemistry Laboratory	..	6
510	General Geology	3	..
530	Lithology	..	3
1010 and 1011	Electricity and Magnetism	3	3
611	Statistical Mechanics	5	..
65 and 66	Bacteriology	..	..
	Second Term:		
43 and 44	Physical Chemistry	2	6
451	Scientific German	5	0
	Electives	12	
			22
	Electives from the following subjects:		
512	General Geology	3	6
513	General Geology Laboratory	..	..
1012 and 1013	Light	3	6
609	Advanced Calculus	5	..
302	Economic Geography	3	..

THIRD YEAR

CURRICULUM V, MECHANICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
652	Mechanics of Materials	3	0
653	Materials Laboratory	0	3
1050 and 1051	Elements of Electrical Engineering	3	3
710	Thermodynamics	3	0
712	Elementary Heat-Power Apparatus	3	3
714	Mechanisms	2	3
			20
	Second Term:		
1052 and 1053	Elements of Electrical Engineering	3	3
34	Fuel and Gas Analysis	0	3
131	Hydraulics	3	3
713	Internal Combustion Engines	3	3
715	Elementary Machine Design	2	3
711	Heating and Ventilation	2	0
			20½
	Summer:		
790	Work in Practice		

THIRD YEAR

CURRICULUM VI, ELECTRICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
652	Mechanics of Materials	3	0
653	Materials Laboratory	0	3
1050 and 1051	Elements of Electrical Engineering	3	0
770	Power Plants	3	3
714	Mechanisms	2	3
41 and 42	Physical Chemistry	3	6
			23
	Second Term:		
1052 and 1053	Elements of Electrical Engineering	3	3
771	Power Plants	3	3
715	Elementary Machine Design	2	3
43 and 44	Physical Chemistry	2	6
1054	Electric Transmission and Distribution	3	3
			22
	Summer:		
1090	Work in Practice		

THIRD YEAR

CURRICULUM VII, CHEMICAL ENGINEERING

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
	First Term:		
651	Theoretical Mechanics	3	0
1050 and 1051	Elements of Electrical Engineering	3	3
41 and 42	Physical Chemistry	3	6
23	Organic Chemistry Aromatic	4	0
24	Organic Chemistry Laboratory	0	6
			20 ½
	Second Term:		
652	Mechanics of Materials	3	0
653	Materials Laboratory	0	3
1052 and 1053	Elements of Electrical Engineering	3	3
43 and 44	Physical Chemistry	2	6
51 and 52	Industrial Chemistry	2	6
25	Organic Chemistry	4	0
			21
	Summer:		
90	Work in Practice		

FOURTH YEAR

CURRICULUM I, MINE ENGINEERING

The following options are offered: 1, **Metal Mining Option;** 2, **Coal Mining Option;** 3, **Mining Geology Option;** 4, **Petroleum Engineering Option.**

Number.	Name of Course.	Option.							
		Metal Mining.		Coal Mining.		Mining Geology.		Petroleum Engineering.	
		Lect.	Lab.	Lect.	Lab.	Lect.	Lab.	Lect.	Lab.
	First Term:								
540	Economic Geology	3	0	..	..	3	0	..	..
770	Power Plants	3	3	3	3	..	..	..	..
831 and 832	Ore Dressing	3	3	3	3	3	3	..	..
808	Metallurgy Laboratory	0	3	..	..	..	..	..	..
305	Economics	3	0	3	0	3	0	3	0
908	Coal Mining	..	..	4	0	..	..	..	..
910	Mine and Mill Design	..	..	2	6	..	..	..	..
543	Field Geology	..	..	..	..	0	6	0	6
518	Stratigraphic Geology	..	..	..	..	3	0	3	0
544	Oil and Gas Geology	..	..	..	..	..	..	3	0
545	Oil and Gas Laboratories	..	..	..	..	..	..	0	3
	Electives	4½[1]	..	3[2]	..	4[3]	..	6[4]	..
	Second Term:								
771	Power Plants	3	3	3	3	..	..	..	..
833 and 834	Ore Dressing	3	3	3	3	3	3	..	..
906	Mining	4	0	4	0	4	0	..	..

306	Economics	3	0	3	0	3	0	3	0
911	Mine and Mill Design	..	..	0	6	..	..	..	..
542	Economic Geology	..	..	3	0	3	0	3	0
520	Structural Geology	..	..	..	..	..	..	3	0
920	Oil Production Methods	..	..	..	..	..	..	3[5]	0
999	Senior Trip (required in all options)	..	..		..	..	..	..	..
	Electives	4½[6]	..	3[7]	..	6[8]	..	8[9]	..

Electives from:

[1]811, 543, 910, 403, 720, 450, 460, 470, M 4.

[2]M 4 may replace 832.

[3]501, 532, 450, 460, 470, 550, 516, 403, 544, 545, M 4. If 501 and 532 are elected, 832 may be omitted.

[4]770, 720, 550, 450, 460, 470, 403, 516, 41, 42, M 4.

Electives from:

[5]If 920 was taken in the Junior Year, choose 11 hours' electives.

[6]911, 813, 451, 461, 471, 302, 542, 404, 131, M 4, 996.

[7]M 4 may replace 834.

[8]534, 522, 520, 521, 451, 461, 471, 404, 920, M 4.

[9]771, 131, 521, 522, 55, 56, 34, 451, 461, 471, 404, 921, M 4.

FOURTH YEAR

CURRICULUM II, METALLURGY

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
	First Term:		
811	Metallurgy of the Non-Ferrous Metals	4	0
863 and 864	Alloys and Metallography	2	6
831	Ore Dressing	3	0
305	Economics	3	0
770	Power Plant	3	3
	Electives[1]	3	
			22½
	Second Term:		
813	Metallurgy of the Non-Ferrous Metals	4	0
865 and 866	Alloys and Metallography	2	3
771	Power Plants	3	3
306	Economics	3	0
	Electives[2]	6	
			21
899	Senior Trip		

[1]Electives to be chosen from the following: 832, Ore Dressing, Laboratory; 812, Metallurgical Laboratory; 896, Thesis; M 4, Military.

[2]Electives to be chosen from the following: 833, 834, Ore Dressing; 836, Ore Dressing Problems; 821, 822, Electrometallurgy; 814, Metallurgical Laboratory; 896, Thesis; M 4, Military.

FOURTH YEAR

CURRICULUM III, CIVIL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
122	Framed Structures	3	6
113	Masonry Design	3	6
1050 and 1051	Elements of Electrical Engineering	3	3
305	Economics	3	0
	Electives	3	
			22½
	Electives from the following subjects:		
132	Water Supply	3	0
450, *or* 460, *or* 470	Modern Language[1]	5	0
M 4	Military	3	0
	Second Term:		
129	Design	0	9
1052 and 1053	Electrical Engineering	3	3
306	Economics	3	0
	Electives	10	
			22
	Electives from the following subjects:		
133	Sewage, Drainage and Irrigation	5	0
134	Hydraulic Power, Motors, Pumps and Fans	2	0
141	Railroad Economics	2	0
404	Discussion and Debate	2	0
451, *or* 461, *or* 471	Modern Language	5	0
904	Mining	4	0
M 4	Military	3	0

[1]Note: Men who elect Modern Language in the first term of the Senior Year must follow it with the second term of the same language.

FOURTH YEAR

CURRICULUM IV, GENERAL SCIENCE

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
	First Term:		
305	Economics	3	0
	Thesis	0	9
	Electives	14	
			21½
	Electives from the following subjects:		
540	Economic Geology	3	..
501	Crystallography	3	..
550	Paeleontology	1	6
532	Petrography	2	6
518	Stratigraphic and Metamorphic Geology	3	..
25	Advanced Organic Chemistry	2	..
45	Advanced Physical Chemistry	2	..
1014 and 1015	Heat	3	3
425	English, Contemporary Drama	3	..
	Second Term:		
306	Economics	3	0
	Thesis	0	9
	Electives	14	
			21½
	Electives from the following subjects:		
542	Economic Geology	3	..
520	Structural Geology	3	..
522	Geology Conference	1	..
47	Chemistry of Colloids	2	..
31	General Principles of Chemistry	..	3
28	Organic Processes	..	6
425	English, Contemporary Drama	3	..
1016 and 1017	Radioactivity	3	3

FOURTH YEAR

CURRICULUM V, MECHANICAL ENGINEERING

The following options are offered: 1, **Power Plant Option;** 2, **Industrial Option;** 3, **Milling and Smelting Option.**

Number.	Name of Course.	Option. Power Plant. Lect.	Power Plant. Lab.	Industrial. Lect.	Industrial. Lab.	Milling and Smelting. Lect.	Milling and Smelting. Lab.
	First Term:						
305	Economics	3	0	3	0	3	0
720	Compressed Air	3	3	3	3	3	3
722	Advanced Machine Design	0	6	0	6	0	6
861	Metals of Engineering	2	0	2	0	..	..
704	General Shop Methods	3	0	..	..	3	0
706	Foundry and Forge Shop Methods	..	..	2	3	..	..
831 and 832	Ore Dressing	..	..	..	..	3	3
903	Mining, Laboratory	..	..	..	..	0	3
	Electives, with at least one non-technical subject	6[1]	..	5[1]	..	3[1]	..

Electives from: [1]450, 460, 470, 403, 424, 425, 861, 728, 302, 1055, 1056, M 4.

CURRICULM V, MECHANICAL ENGINEERING—Continued.

Number,	Name of Course.	Option.					
		Power Plant.		Industrial.		Milling and Smelting.	
		Lect.	Lab.	Lect.	Lab.	Lect.	Lab.
	Second Term:						
306	Economics	3	0	3	0	3	0
721	Steam Turbines	3	3	3	3	3	3
723	Power Plant Auxiliary Apparatus	3	0	3	0	3	0
725	Plant Design	0	6	..	..	..	..
727	Refrigeration	3	0	..	..	..	..
307	Labor Problems	..	..	2	0	..	..
707	Machine Shop Methods	..	..	2	3	..	..
807 and 808	Principles of Metallurgy	..	..	..	..	3	3
833 and 834	Ore Dressing	..	..	..	..	3	3
	Electives, with at least one non-technical subject	6[2]	..	5[2]	..	3[2]	..

Electives from: [2]451, 452, 453, 404, 425, 308, 1057, 1058, 725, 729, M 4.

FOURTH YEAR

CURRICULUM VI, ELECTRICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.	
	First Term:			
305	Economics	3	0	
1055	Electrical Machinery	3	0	
1056	Electrical Machinery	0	3	
1059	Power Stations	3	3	
861	Metals in Engineering	2	0	
722	Advanced Machine Design	0	6	
	Electives	5		
				22
	Electives from the following subjects:			
1025	Alternating Current Theory	3	..	
403	Engineering English	2	..	
450, *or* 460, *or* 470	Modern Language	5	..	
M 4	Military	3	..	
	Second Term:			
306	Economics	3	0	
1057	Electrical Machinery	3	0	
1058	Electrical Machinery	0	3	
1060	Electric Railways	3	3	
1096	Thesis and Design	0	12	
	Electives	5		
				23
	Electives from the following subjects:			
1026	Alternating Current Theory	3	..	
404	Discussion and Debate	2	..	
451, *or* 461, *or* 471	Modern Language	5	..	
M 4	Military	3	..	

FOURTH YEAR

CURRICULUM VII, CHEMICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	First Term:		
305	Economics	3	0
450	Elementary German	5	0
770	Power Plant	3	3
53 and 54	Industrial Chemistry, Inorganic	2	6
	Electives[1]	6	
			23½
	Second Term:		
306	Economics	3	0
451	Scientific German	5	0
771	Power Plant	3	3
55 and 56	Industrial Chemistry, Organic	2	6
99	Senior Trip		
	Electives[1]	6	
			23½

[1]Subject to be chosen by consultation with head of department. Students in R. O. T. C. will take as one subject Military M 4.

VOCATIONAL COURSE

VIII, TOPOGRAPHIC ENGINEERING

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
1100	Topographic Engineering	3	0
1101	Topographic Office Practice	0	6
1102	Topographic Field Practice	0	35
1103	Geodetic Computations	1	0
1104	Physiography	2	0
1105	Physiography, Laboratory	0	3
1111	Practical English	3	0
1112	Conversational Spanish	2	0
1106	[1]Practical Mathematics	3	0
1107	[1]Practical Algebra	5	0
1108	[1]Advanced Algebra	5	0
1109	[1]Practical Trigonometry	5	0
1110	[1]Advanced Trigonometry	5	0

[1]The student will be assigned to courses in mathematics listed above, according to his previous training. The student will not find it advisable to pursue more than two of the courses offered in mathematics.

VOCATIONAL COURSE

VIII, HIGHWAY ENGINEERING

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
1113	Highway Engineering	3	0
1114	Highway Engineering, Laboratory	0	15
1115	Highway Field Practice	0	21
1116	Highway Field and Office Computations	0	14
1111	Practical English	3	0
1106	[1]Practical Mathematics	5	0
1107	[1]Practical Algebra	5	0
1109	[1]Practical Trigonometry	5	0
1108	[1]Advanced Algebra	5	0
1110	[1]Advanced Trigonometry	5	0

[1]The student will be assigned to courses in mathematics listed above, according to his previous training. The student will not find it advisable to pursue more than two of the courses offered in mathematics.

VOCATIONAL COURSE

VIII, OIL FIELD ENGINEERING

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
1117	Oil Engineering Drafting	0	6
1118	Graphic Presentation of Oil Statistics	2	4
1119	Valuation of Oil Properties	1	3
1104	Physiography	2	0
1105	Physiography, Laboratory	0	3
1111	Practical English	3	0
1112	Conversational Spanish	2	0
1106	[1]Practical Mathematics	5	0
1107	[1]Practical Algebra	5	0
1108	[1]Advanced Algebra	5	0
1109	[1]Practical Trigonometry	5	0
1110	[1]Advanced Trigonometry	5	0

[1]The student will be assigned to courses in mathematics listed above, according to his previous training. The student will not find it advisable to pursue more than two of the courses offered in mathematics.

VOCATIONAL COURSE

VIII, ARCHITECTURAL DRAWING

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
1120	Architectural Drawing	0	6
1111	Practical English	3	0
1106	[1]Practical Mathematics	3	0
1107	[1]Practical Algebra	5	0
1108	[1]Advanced Algebra	5	0
1109	[1]Practical Trigonometry	5	0
1110	[1]Advanced Trigonometry	5	0
	[2]Electives	0	9

[1]The student will be assigned to courses in mathematics listed above, according to his previous training. The student will not find it advisable to pursue more than two of the courses offered in mathematics.

[2]In addition to the above subjects, nine hours of electives are to be chosen.

DEPARTMENTS OF INSTRUCTION

In the following statement of courses, the departments of instruction are arranged alphabetically.

The number of each course identifies the department in which it is given, the numbers being apportioned to the several departments as follows:

Chemistry	1 - 99
Civil Engineering	100 - 199
Drawing	200 - 299
Economics	300 - 399
English and Modern Languages	400 - 499
Geology	500 - 599
Hygiene and Student Health	60 - 75[1]
Mathematics	600 - 649
Mechanical Engineering	700 - 799
Mechanics	650 - 699[2]
Metallurgy	800 - 899
Mining	900 - 999
Physics and Electrical Engineering	1000 - 1099
Vocational Training (Federal Board)	1100 - 1199
Military Science and Tactics	M
Physical Education	PE

In the description of each course are stated the curricula in which the course is required. Numbers in parentheses designate the courses which the student must have completed as prerequisite to his admission to the course described.

No student is admitted to any course unless he has fulfilled all the requirements for that course as stated in the Catalogue, or has otherwise satisfied the instructor that he is prepared to pursue it.

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[1]Represents numbers lent by Department of Chemistry.

[2]Represents numbers lent by Department of Mathematics.

CHEMISTRY

PROFESSOR TURNER, ASSOCIATE PROFESSOR DUNLAP, MR. KERSHNER, MR. LANE, MR. FISCHLOWITZ, MR. NUDELMAN, MR. BADOLLET

EQUIPMENT.

One entire building is devoted to chemistry. The laboratories for general chemistry, on the first floor of the main building, accommodate together about one hundred sixty students. The quantitative laboratories on the second floor have desk room for ninety students. The north wing contains a lecture room, and a spacious laboratory for industrial chemistry with a small auxiliary commercial analytical laboratory.

In the south wing are a large lecture room seating 150 and a small class room, while in the basement are laboratories for physcal, organic and theoretical chemistry, accommodating twenty to forty students each, together with a lecture room with a capacity of 48.

The equipment includes 160 outfits for Freshman chemistry and qualitative analysis; 90 outfits for gravimetric and volumetric analysis (including excellent analytical weights, platinum crucibles and standardized burettes); 24 outfits for physical chemistry, together with an adequate selection of precision instruments and accessories; 30 outfits for organic chemistry; and an ample replacement stock. Excellent ventilation is provided by a suction fan system connected with individual hoods over each laboratory desk and with the fume chambers distributed throughout the building. Gas, water, compressed air and electrical power are supplied conveniently, while a steam-heated water still furnishes ample distilled water.

The machines installed in the industrial laboratory include mixing and grinding machines, filter presses, centrifuges, apparatus for distillation and rectification of liquids, apparatus for dry distillation of woods, etc., caustic pot, nitrator, sulphanator, fusion kettle, autoclave, glass enameled, non-corrosive and standard kettles, drying ovens, mixing and storing tanks, and the incidentals necessary for the preparation of commercial chemicals, soaps, paints, wood products, pharmaceuticals, oils, etc.

The department has secured the co-operation of some of the chemical manufacturing concerns and has prepared for exhibition a Museum of Industrial Chemistry. Exhibits of the raw material and products illustrating the processes in many of the industries are displayed.

COURSES

1. GENERAL CHEMISTRY. *Lectures.*

Freshman year, first term, 16 weeks, three hours per week.
All curricula:
Text: Alexander Smith, *General Chemistry for Colleges.*
Mr. Kershner.

A comprehensive study of the general principles of chemistry and of the more important non-metals. The fundamental laws of chemistry are developed in logical order, special attention being given to their application in practical computations. Carefully designed lecture experiments are a feature of the course. The class is divided into several smaller sections for recitation and discussion of problems.

2. GENERAL CHEMISTRY. *Laboratory.*

Freshman year, first term, 16 weeks, six laboratory hours per week.
All curricula: Must be accompanied by (1).
Text: *Mimeograph Notes.*
Alexander Smith, *Laboratory Outline of General Chemistry.*
Mr. Kershner, Mr. Badollet, Mr. Nudelman.

The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

3. GENERAL CHEMISTRY. *Lectures.*

Freshman year, second term, 16 weeks, four hours per week.
All curricula: (1 and 2.)
Text: Same as in 1.
Mr. Kershner.

Continuation of course 1; devoted to the chemistry of the metals, with special consideration of the reactions employed in analytical chemistry. The ionic theory, mass law, etc., are introduced and applied at advantageous points in the lectures.

4. GENERAL CHEMISTRY. *Laboratory.*

Freshman year, second term, 16 weeks, three laboratory hours per week.
All curricula: (1 and 2.)
Texts: Same as in 2.
Mr. Kershner, Mr. Badollet, Mr. Nudelman.

Continuation of course 2.

6. QUALITATIVE ANALYSIS. *Laboratory.*

Freshman year, second term, 16 weeks, six laboratory hours per week.

All curricula: (1 and 2.)

Text: Same as in 2 and *Mimeograph Notes.*

Mr. Kershner, Mr. Badollet, Mr. Nudelman.

This course is to accompany the study of the metals in general chemistry and is devoted to the qualitative separation and detection of the metals.

7. ANALYTICAL CHEMISTRY. *Lectures.*

Sophomore year, first term, 16 weeks, two hours per week.

Curricula: I, II, IV, VII (3 and 6; to be accompanied by 8).

Text: Smith, *Quantitative Analysis.*
Manuscript Notes.

Professor Turner.

The first few periods will be devoted to a discussion of the theory underlying analytical methods. During the remainder of this course the following subjects will be discussed: The balance, weights, and the process of weighing; the gravimetric operations; typical gravimetric analyses; volumetric instruments, their calibration and use; standard solutions; indicators; and typical volumetric analyses.

Problems in the calculations of analytical chemistry are a feature of the course.

8. GRAVIMETRIC ANALYSIS. *Laboratory.*

Sophomore year, first term, 16 weeks, six laboratory hours per week.

Curricula: I, II, IV, VII (to be accompanied by 7).

Text: Smith, *Quantitative Analysis.*
Manuscript Notes.

Professor Turner, Mr. Fischlowitz.

It is purposed in this course to lay a broad foundation of analytical principles upon which the student may build by subsequent practice.

The applications of the principles of quantitative analysis as illustrated in the simpler gravimetric determinations are taken up.

10. VOLUMETRIC ANALYSIS. *Laboratory.*

Sophomore year, second term, 16 weeks, six laboratory hours per week. Curricula: I, II, IV, VII (8).

Text: Same as in 8.

Professor Turner, Mr. Fischlowitz.

A study of the standard elementary volumetric methods, together with technical methods for the determination of iron, copper, lead, zinc, arsenic, antimony, etc.

Actual ores, analyzed by the instructing staff, are on hand in quantity, and the students are trained to attain at least the degree of accuracy which obtains in analytical laboratories.

12. INDUSTRIAL ANALYSIS. *Laboratory.*

Elective, 16 weeks, six laboratory hours per week. (10 and 22).

Text: *Mimeograph Sheets.*
Library References.

Mr. Fischlowitz.

General methods in industrial analysis. The course is designed to illustrate principles and to develop ability in selecting and adapting the methods of standard reference works.

14. MINERAL ANALYSIS. *Laboratory.*

Elective, 16 weeks, six laboratory hours per week. (10.)

Mr. Fischlowitz.

Offered primarily for students who desire to become acquainted with the methods of analysis of matters, speisses, crude and refined lead and copper bullion, spelter, alloys and similar material. No required schedule is laid out.

16. WATER ANALYSIS. *Laboratory.*

Elective, 16 weeks, six laboratory hours per week. (10).

Mr. Fischlowitz.

Designed to meet the wants of engineering students. Sanitary and industrial water analysis are offered, although students interested in geology may substitute mineral water analysis for some of the work.

18. ORGANIC ANALYSIS. *Laboratory.*

Elective, 16 weeks, six laboratory hours per week. (10 and 22).

Mr. Fischlowitz.

A laboratory course in the analysis of commercial organic products.

21. ORGANIC CHEMISTRY, ALIPHATIC. *Lectures.*

Sophomore year, second term, 16 weeks, two hours per week.
Curriculum: VII (7).
Text: Cohen, *Theoretical Organic Chemistry.*

Associate Professor Dunlap.

An introduction to the simple organic compounds. Special emphasis is placed on the structure and nomenclature of the aliphatic series.

22. ORGANIC CHEMISTRY. *Laboratory.*

Sophomore year, second term, 16 weeks, six laboratory hours per week.
Curriculum: VII (Must be accompanied by 21).
Text: Cohen, *Practical Organic Chemistry.*

Associate Professor Dunlap.

Preparation and purification of typical aliphatic compounds, illustrating general methods of synthesis and technique of manipulations.

23. ORGANIC CHEMISTRY, AROMATIC. *Lectures.*

Junior year, first term, 16 weeks, four hours per week.
Curriculum: VII (21).
Text: As in 21.

Associate Professor Dunlap.

A continuation of 21, extending the consideration to aromatic compounds. The course is introduced by a study of stereo-isomerism based on the chemistry of the carbohydrates.

24. ORGANIC CHEMISTRY. *Laboratory.*

Junior year, first term, 16 weeks, six laboratory hours per week.
Curriculum: VII (Must be accompanied by 23).
Text: As in 22.

Associate Professor Dunlap.

A continuation of 22, illustrating important synthetic processes for typical aromatic compounds, together with a study of the conditions of reactions.

25. ORGANIC CHEMISTRY, HETEROCYCLIC. *Lectures.*

Junior year, second term, 16 weeks, two hours per week.
Curriculum: VII (23).
Text: As in 21.

Associate Professor Dunlap.

A study of amino acids, uric acids, terpenes and some of the more complex aliphatic and aromatic compounds.

26. ADVANCED ORGANIC CHEMISTRY. *Laboratory.*

Six laboratory hours per week.
Elective. (25).

Associate Professor Dunlap.

Advanced preparations followed by intensive study of problems selected for the special needs and ability of the student.

28. ORGANIC PROCESSES. *Laboratory.*

Six laboratory hours per week.
Elective (26).

Associate Professor Dunlap.

Students are assigned special problems according to their training and preferences.

31. GENERAL PRINCIPLES OF CHEMISTRY

Senior year, second term, 16 weeks, three hours per week.
Elective (43 and 53).
Text: Noyes & Sherrill, *General Principles of Chemistry.*

Professor Turner.

A course designed to correlate the prerequisite inorganic, analytical, organic, physical and industrial courses and to give training in the application of the general principles of chemistry through the solution of various problems.

34. FUEL AND GAS ANALYSIS. *Laboratory.*

Sophomore year, second term, 16 weeks, three laboratory hours per week.
Curricula: V and VI (4).
Text: Gill, *Engine Room Chemistry.*

Professor Turner, Mr. Fischlowitz.

A practical course in fuel and gas-testing, especially adapted to the needs of engineering students.

41. PHYSICAL CHEMISTRY. *Lectures.*

Junior year, first term, 16 weeks, three hours per week.
Curricula: II and VII (7, Physics 1002, 1003; to be accompanied by 42).
Text: Lincoln, *A System of Physical Chemistry.*
Manuscript Notes. Professor Turner.

An introductory study of the physical properties of gases, pure liquids, and simple solutions, with applications of mass law phase rule, optical study, etc.

42. PHYSICAL CHEMISTRY. *Laboratory.*

Junior year, first term, 16 weeks, six laboratory hours per week.
Curricula: II and VII (8; to be accompanied by 41).
Text: Findlay, *Practical Physical Chemistry.*

Professor Turner.

Laboratory to accompany 41.

43. PHYSICAL CHEMISTRY. *Lectures.*

Junior year, second term, 16 weeks, two hours per week.
Curricula: II and VII (41).
Text: Same as in 41.

Professor Turner.

A continuation of 41, introducing a discussion of ionization, electrolysis, polarization, conductance, hydration, etc., in solution; equilibrium and speed of reactions.

44. PHYSICAL CHEMISTRY. *Laboratory.*

Junior year, second term, 16 weeks, six laboratory hours per week.
Curricula: II and VII (Must be accompanied by 43).
Text: Findlay, *Practical Physical Chemistry.*
Watts, *Laboratory Course in Electro-Chemistry.*

Professor Turner.

Measurements of ionization, conductivity, electro-motive force, resistance, single potentials; electro-deposition of metals, etc. A continuation of 42.

45. ADVANCED PHYSICAL CHEMISTRY. *Lectures.*

Senior year, first term, 16 weeks, two hours per week.
Elective (43).
Text: *Library References.*

Professor Turner.

A discussion of physico-chemical topics such as: Phase rule, osmosis, hydrolysis, transference, etc.

47. THE CHEMISTRY OF COLLOIDS.

Senior year, second term, 16 weeks, two hours per week.
Elective on approval of the instructor (43).
Text: Zsigmondy, *Colloids.*

Associate Professor Shaw.

A review of the development of the theory of colloids, together with laboratory demonstrations to illustrate the modern practice in the study of the subject.

51. INDUSTRIAL CHEMISTRY, GENERAL PROCESSES. *Lectures.*

Junior year, second term, 16 weeks, three hours per week.
Curriculum: VII (23; must be accompanied by 52).
Text: Rogers, *Industrial Chemistry.*
Kremenn-Potts, *Applications of Physico-Chemical Theory.*
Manuscript Notes.
Library References.

Mr. Kershner.

A survey of the classification of industrial chemical literature, followed by a study of the types of plant and apparatus used in chemical operations.

52. INDUSTRIAL CHEMISTRY, GENERAL PROCESSES. *Plant.*

Junior year, second term, six laboratory hours per week.
Curriculum: VII (24; must be accompanied by 51).
Text: Rogers, *Laboratory Guide to Industrial Chemistry.*
Manuscript Notes and Blue Prints.
Library References.

Associate Professor Dunlap.

Designed to accompany the lectures in General Industrial Chemistry training the student to adapt his knowledge to large-scale operations through the actual manipulation of the apparatus studied in the classroom.

53. INDUSTRIAL CHEMISTRY, INORGANIC. *Lectures.*

Senior year, first term, 16 weeks, two hours per week.
Curriculum: VII (51).
Text: *Library References.*
Manuscript Notes and Blue Prints.

Associate Professor Dunlap.

A study of typical inorganic chemical industries.

54. INDUSTRIAL CHEMISTRY, INORGANIC. *Plant.*

Senior year, first term, 16 weeks, six laboratory hours per week.
(52; to be accompanied by 53).
Text and References: As above.

Associate Professor Dunlap.

The industrial preparation of typical inorganic products.

55. INDUSTRIAL CHEMISTRY, ORGANIC. *Lectures.*

Senior year, second term, 16 weeks, two hours per week.
(53; to be accompanied by 56).
Text and References: As in 53.

Associate Professor Dunlap.

A study of typical organic chemical industries.

56. INDUSTRIAL CHEMISTRY, ORGANIC. *Plant.*

Senior year, second term, 16 weeks, six laboratory hours per week.
(54; to be accompanied by 55).
Text and References: As above.

Associate Professor Dunlap.

The industrial preparation of typical organic products.

57. CHEMICAL INDUSTRIES. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Curriculum: VII (51).
Text: Ely, *Outlines of Economics.*
Manuscript Notes.

Professor Turner.

The application of economic principles in the chemical industries.

58. CHEMICAL ENGINEERING DATA. *Library.*

Senior year, second term, 16 weeks, three hours per week.
(52.)

Professor Turner.

A course designed to supplement the work described in 57, consisting mainly of the collection and interpretation of data on the administrative as well as the scientific side of Chemical Manufacturing.

59. CHEMICAL INDUSTRIES. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
Curriculum: VII (51).
Text: *Library References.*

Professor Turner.

The course is similar to 57, except that different specific industries are studied.

68. MICROSCOPY OF TECHNICAL PRODUCTS.

Laboratory.

See Department of Hygiene and Student Health, page 95.

90. WORK IN PRACTICE.

Summer vacation following the Junior year.
Required in Curriculum VII.

To receive a degree in Chemical Engineering, the student (a) must have worked not less than twelve weeks in some chemical plant; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some chemical plant designated by the head of the department; or (c) a regularly supervised inspection trip may be taken in place of this practice work or observation, provided such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

96. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Elective (43, 51 or 64).

Professor Turner, Associate Professor Dunlap,
Mr. Kershner.

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to the specifications described on page 34.

99. SENIOR TRIP.

Senior year, second term.

Required in Curriculum VII.

During the second term of the senior year, a two weeks' trip is taken either to St. Louis and vicinity or to Chicago and vicinity, for the purpose of studying chemical engineering plants and methods in these districts.

CIVIL ENGINEERING

Professor Harris, Associate Professor Armsby, Mr. Butler.

The Department of Civil Engineering has its lecture rooms, drafting rooms, offices and department library in Norwood Hall. The hydraulics laboratory and the locker rooms for field equipment are in the Power Plant Building.

The cement testing laboratory, with office and supply room, is located in the ground floor of Parker Hall.

The plan of study is designed to afford training such that the graduates will be prepared to perform at once the minor duties in the various branches of the profession. Especial stress is laid upon proficiency in field work, drafting, and the design and inspection of the more common engineering structures.

For field work the department is equipped with twenty transits, five of which are complete mining instruments with side and top telescopes; and eighteen wye and dumpy levels, representing the principal makes and types of construction. Additional equipment includes a solar compass, a surveyor's compass, three geologist's compasses, four Brunten transits, twenty plane tables, two sextants, and a liberal supply of hand levels, barometers, clinometers, dip-needles, angle prisms, chains, tapes, level rods, stadia rods, range poles, etc.

The field work is so outlined that the student has an opportunity to judge the relative merits of the various types of field instruments.

An important feature of the instrument room is the locker system. Due to the scope of the equipment it has been possible to arrange in separate lockers complete equipment for each surveying squad.

The department has at its disposal three well-equipped drafting rooms.

The cement testing laboratory is equipped for making complete physical tests of cement, concrete, and concrete aggregates, and for investigations into the proper proportioning of concrete. The equipment consists of two standard tension testing machines, two Vicat apparatus, several specific gravity apparatus, one electric drying oven, one standard steamer, an autoclave, a moist closet, apparatus for the determination of specific gravity of, and voids in, concrete aggregates, several sets of standard sieves, standard cylindrical molds for concrete, and an ample supply of standard tension briquette molds, graduates, trowels, spatulas, and other small apparatus.

COURSES.

102. PLANE SURVEYING. *Lectures and Laboratory.*

Freshman year, first term, 16 weeks, two lectures and six hours laboratory per week.

All curricula (must be preceded or accompanied by course 600).

Texts: Breed & Hosmer, *Principles and Practice of Surveying*, Vol. I.

Mr. Butler.

The theory and practice of plane surveying, including the adjustments and uses of transits, levels, and minor instruments; land surveying; traversing; leveling; determination of meridian; mapping; and the usual computations used in connection with plane surveying. The notes taken in the field are used for computation and mapping, helping to emphasize the practical nature of the work done, as well as affording a check on the field work.

The simpler problems are conducted on and about the campus, the work being referenced to stations of a triangulation system, the bearings and lengths of sides of which have been accurately determined, thus affording checks on the accuracy of the student work.

104. TOPOGRAPHIC SURVEYING. *Laboratory.*

Freshman year, second term, 16 weeks, six hours per week.

Curriculum: III; optional in other curricula (102).

Text: Breed & Hosmer, *Principles and Practice of Surveying*, Vol. II.

Associate Professor Armsby, Mr. Butler.

A continuation of the work given in course 102, with the addition of some of the simpler astronomical observations, base line measurement, triangulation, stadia and plane table work, road traversing, and other problems. A complete topographical map of a small area is made.

107. RAILROAD SURVEYING. *Lectures and Laboratory.*

Sophomore year, first term, 16 weeks, two lectures and six hours laboratory per week.

Curriculum: III (104).

Text: Searles & Ives, *Field Engineering.*

Mr. Butler.

A study of the theory of simple, compound, and reverse curves; frogs and switches; turnouts and cross-overs; and earthwork. The laboratory periods are devoted to the solution of typical problems, and are conducted in the field so far as the weather permits.

108. HIGHWAY ENGINEERING. *Lectures and Laboratory.*

Junior year, first term, 16 weeks, three lectures and nine hours laboratory per week.

Curriculum: III (107).

Text: Agg, *Construction of Roads and Pavements.*

Mr. Butler.

Designed to prepare the student for positions of minor responsibilities in highway engineering. It treats of the character and types of common roads and pavements; the types of minor highway structures; the testing of materials for highway construction; and the study of approved plans, specifications and estimates. A complete relocation of an existing highway is made, and from this plans are prepared and an estimate of cost outlined.

111. MASONRY CONSTRUCTION. *Lectures and Laboratory.*

Junior year, first term, 16 weeks, three lectures and three hours laboratory per week.

Curriculum: III (must be preceded or accompanied by 605 and 606).

Text: Baker, *A Treatise on Masonry Construction.*

Associate Professor Armsby.

A study of the fundamental principles underlying the selection, testing, preparation, and use of the various building materials in masonry structures. The treatment of ordinary and pile foundations, foundations under water, dams, retaining walls, piers, abutments, and culverts are successively studied.

The laboratory time is devoted chiefly to the testing of cement, concrete, and materials used in making concrete.

112. REINFORCED CONCRETE. *Lectures and Laboratory.*

Junior year, second term, 16 weeks, three lectures and six hours laboratory per week.

Curriculum: III (111, 605 and 606).

Texts: Turneaure & Maurer, *Principles of Reinforced Concrete Construction.*

Professor Harris.

The theory and design of reinforced concrete beams, slabs, tanks, dams, culverts, conduits, retaining walls, and columns.

113. MASONRY DESIGN. *Lectures and Laboratory.*

Senior year, first term, 16 weeks, three lectures and 6 hours laboratory per week.

Curriculum: III (112).

Text: Baker, *A Treatise on Masonry Construction.*
Turneaure & Maurer, *Principles of Reinforced Concrete Construction.*
Wegmann, *High Masonry Dams.*

Professor Harris.

A continuation of courses 111 and 112. Includes the analysis and design of high masonry dams, reinforced concrete dams, long-span arches, concrete standpipes, reservoirs, and the like.

121. STRESSES. *Lectures and Laboratory.*

Junior year, second term, 16 weeks, three lectures and six hours laboratory per week.

Curriculum: III (605 and 606).

Text: Johnson, Bryan & Turneaure, *Modern Framed Structures*, Vols. I and III.

Associate Professor Armsby.

Graphic and analytic determination of stresses in the simpler engineering structures, such as derricks, roof trusses, and single span bridges, under their various loads. Some time is spent on the fundamentals of structural design.

122. FRAMED STRUCTURES. *Lectures and Laboratory.*

Senior year, first term, 16 weeks, three lectures and six hours laboratory per week.

Curriculum III (121).

Text: Same as in 121.

Associate Professor Armsby.

A continuation of course 121, covering the complete detailed design, with estimates and bills of materials, of plate girders, bridges, roof trusses, towers, steel building frames and the like.

129. DESIGNING. *Laboratory.*

Senior year, second term, 16 weeks, nine hours per week.

Curriculum: III (113 and 122).

Professor Harris.

The work in this course is selected to accord with the line of work in which the student expects or desires to specialize. He is required to find his material in the library, and to inform himself

as to the best current practice relative to the problem assigned. Throughout the term the student is required to keep informed as to the current Civil Engineering literature.

131. HYDRAULICS. *Lectures and Laboratory.*

Junior year, second term, 16 weeks, three lectures and three hours laboratory per week.
Curriculum: III, Elective V (605 and 606).
Text: Merriman, *Elements of Hydraulics.*
Professor Harris.

The theory of hydrostatics and hydraulics, and its application to the dependent problems in engineering practice; determination of empirical coefficients and their application in determining the flow of water through orifices, weirs, pipes, canals, and rivers.

132. WATER SUPPLY. *Lectures.*

Senior year, first term, 16 weeks, three lectures per week.
Elective Curriculum: III (112 and 131).
Texts: Turneaure & Russell, *Public Water Supplies.*
Assistant Professor Mann.

Selection, storing, transporting, purification, and delivery of water to cities and towns.

133. SEWAGE, DRAINAGE, AND IRRIGATION. *Lectures.*

Senior year, second term, 16 weeks, five lectures per week.
Elective in Curriculum: III (131).
Texts: Folwell, *Sewage of Cities.*
Elliot, *Land Drainage.*
Wilson, *Irrigation.*
Professor Harris.

These subjects, having much in common, are grouped together to avoid duplication and repetition. The course includes textbook work, lectures, and research by the student in the library. It is usual to include in course 129 some structure the design of which would require information derived from this course.

134. HYDRAULIC POWER, MOTORS, PUMPS, AND FANS. *Lectures.*

Senior year, second term, 16 weeks, two lectures per week.
Elective in Curriculum III (131).
Texts: Mead, *Water Power.*
Dougherty, *Hydraulic Motors and Pumps.*
Harris, *Compressed Air.*
Professor Harris.

A continuation of course 131. Includes the theory of hydraulic motors and centrifugal pumps and fans; the various problems of water power development on rivers; and the economic effect of water storage on water power and the control of floods.

141. RAILROAD ECONOMICS. *Lectures.*

Senior year, second term, 16 weeks, two lectures per week.
Elective in Curriculum III (107).
Texts: Williams, *Design of Railroad Location.*
Webb, *Railroad Construction.*
Current Engineering Literature.
Associate Professor Armsby.

The economic principles involved in the location, revision, operation, and financing of railroads. The work covers train resistances under varying conditions of traffic, grade, and curvature; locomotive performance; valuation of railroad properties; grade separation, etc.

190. WORK IN PRACTICE.

Summer vacation following the Junior year.
Required in Curriculum III.

To receive a degree in Civil Engineering, the student (a) must have worked not less than twelve weeks in some industry or project related to civil engineering; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching at some engineering project or industry designated by the head of the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

196. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.
Elective.

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to the specifications described on page 34.

DRAWING

Assistant Professor Mann.

The south side of the third floor of Norwood Hall is given over to the work in engineering drawing. This space includes three drafting rooms, an office, and a blue printing room.

The drafting rooms are equipped with seventy-five double and thirty-two single drawing desks which are arranged to accommodate the individual drawing boards, T-squares, and instruments of each student in drawing. In addition, lockers are available for fifty-four students.

The blue printing room is equipped with a Pease vertical electric printing machine; a Pease wall print washer; a large frame, for sun printing, which is mounted on a rolling carriage; a convenient paper-cutting table; and small printing frames and other miscellaneous equipment.

The aims of the general courses in drawing are so to train the student in the execution of lettering, line and detail drawing, that he will acquire habits of neatness and accuracy, system in his work, knowledge of the proper decorum in a large drafting room, and the ability to produce neat, accurate, and creditable drawings in the minimum of time consistent with good work. He is thoroughly drilled in the fundamental principles of projection as applied to engineering drawing, and is taught how to make blue prints, and something of the various other commercial methods of reproducing drawings. The more advanced courses aim to provide the student with drafting technique and drawing problems peculiar to the sevral specialized branches of engineering and general science.

211. ELEMENTARY DRAWING. *Laboratory.*

Freshman year, first term, 16 weeks, two laboratory periods of three hours each per week.

Curricula I, II, III, V, VI, VII.

Text: French, *Engineering Drawing.*

Assistant Professor Mann.

Designed to give the student a practical working knowledge of correct methods in line and figure drawing with drawing instruments, and in the analysis and execution of standard engineering style of freehand single-stroke lettering. The fundamental principles of orthographic, isometric, oblique, and cabinet projection are covered. Practice is given in lettering, line and

figure drawning, simple machine sketching, dimensioning, tracing and blue printing.

212. DESCRIPTIVE GEOMETRY. *Laboratory.*

Freshman year, second term, 16 weeks, two laboratory periods of three hours each per week.

Curricula I, II, III, V, VI, VII (211).

Text: Blessing and Darling, *Elements of Descriptive Geometry.*

Assistant Professor Mann.

Orthographic projection of points, lines, planes, curves, curved surfaces and solids in the four angles of projection; intersections and developments; and linear perspective. Many geometric problems and exercises of practical application to engineering are given the student to work out, together with a series of plates.

221. ADVANCED MECHANICAL DRAWING. *Laboratory.*

Sophomore year, first term, 16 weeks, two laboratory periods of three hours each per week.

Curricula III, V, VI (211, 212).

Text: Marshall, *Elementary Machine Drawing and Desigr.*

Assistant Professor Mann.

Aims to familiarize the student with modern drafting room practice, drafting technique and conventions peculiar to mechanical electrical, and structural engineering design; and to prepare him for the advanced work of design in his chosen field. Appropriate exercises in drawing are given.

222. CIVIL ENGINEERING DRAWING. *Laboratory.*

Sophomore year, second term, 16 weeks, 2 laboratory periods of three hours each per week.

Curricula I, (Coal Mining Elective), and III, (211, 212).

Text: French, *Engineering Drawing,*

Department Notes.

Assistant Professor Mann.

Meets certain special needs of civil and mining engineering students, such as freehand lettering for titles and maps; selection of titles of plain but good form; plotting and mapping methods; topographic conventions and symbols; the technique of drafting as applied to structural, bridge, highway, and concrete design; maps for mines; and the drawing and tracing of standard types of engineering structures and structural parts.

223. MACHINE DRAWING. *Laboratory.*

Sophomore year, second term, 16 weeks, one three-hour laboratory period per week.

Curricula V and VI (211, 212, 222).

Texts: Marshall, *Elementary Machine Drawing and Design. Department Notes and References.*

Assistant Professor Mann.

A specialized continuation of 221, in which the empirical design and drawing of simple machines and machine parts is taken up. Detailed and assembly drawings of machines are made.

251. ADVANCED CIVIL ENGINEERING DRAWING. *Laboratory.*

Junior or Senior year or Graduate Course. Either term as arranged, 16 weeks, two laboratory periods of three hours each per week.

Curriculum III and Graduates of III (211, 212, 222).

Text: *Department Notes.*

Assistant Professor Mann.

Complete design drawings are made for some project or intricate civil engineering structure, as for example, a steel bridge or a dam. Sets of plans and specifications for various structures are studied in detail.

252. ADVANCED MACHINE DRAWING. *Laboratory.*

Junior or Senior year or Graduate Course. Either term as arranged, 16 weeks, one three-hour laboratory period per week.

Curricula V and VI (211, 212, 223).

Text: *Department Notes.*

Assistant Professor Mann.

Complete designs of a more or less intricate machine are drawn, and sets of plans and specifications for such machines are studied in detail.

253. ADVANCED MAPPING AND TOPOGRAPHICAL DRAWING. *Laboratory.*

Junior or Senior year or Graduate Course. Either term as arranged, 16 weeks, two laboratory periods of three hours each per week.

Curricula I, III, or graduates thereof (211, 212, 222).

Text: *Department Notes.*

Assistant Professor Mann.

A study of intricate topographic maps and mapping methods used by the United States Geological and Geodetic surveys and

similar organizations; interpretation of topographic maps; and exercise in drawing of relatively difficult topographic maps from notes.

254. FORMULA CHARTING, or GRAPHING. *Laboratory.*

Junior or Senior years or Graduate Course. Either term as arranged, 16 weeks, one three-hour laboratory period per week.

Primarily for General Science Curriculum IV, may be taken by students in any other, or by graduates thereof (211).

Text: *Department Notes.*

Assistant Professor Mann.

A study in the plotting of mathematical formulae and equations commonly met with by engineers and scientists. Interpretation and practical application of graphs.

ECONOMICS

Assistant Professor Boyce.

The work in this department, while very valuable to the student from a purely business and professional point of view, is designed primarily to enable him to think logically and intelligently upon present-day problems—to enable him rightly to decide those questions of both public and private policy which come up before every one in his capacity as a member of the various groups in which he finds himself. In other words, the purpose of the courses here listed is to train for citizenship rather than for business in the narrow sense of the word. But even to the would-be purely business man, a knowledge of the economic and social problems of the day is no mean asset.

301. ECONOMIC HISTORY OF THE UNITED STATES. *Lectures.*

First term, 16 weeks, three hours per week.
Elective in any curriculum, with consent of faculty.

Assistant Professor Boyce.

The agricultural, commercial, and industrial development of the United States from the beginning of colonization down to the present; the effect upon this development of our natural resources, of slavery, of the British colonial policy, of our tariffs; why different sections developed along different lines.

302. ECONOMIC GEOGRAPHY. *Lectures.*

Second term, 16 weeks, three hours per week.
Elective in any curriculum, with consent of the faculty.

Assistant Professor Boyce.

Natural resources of the world; products and industries of different countries and the cause of their location.

305. PRINCIPLES OF ECONOMICS. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
All curricula.

Assistant Professor Boyce.

The basic principles of the science and their practical applications to present-day problems.

306. PRINCIPLES OF ECONOMICS. *Lectures.*

Senior year, second term, 16 weeks, three hours per week. All curricula.

Assistant Professor Boyce.

A continuation of 305.

307. LABOR PROBLEMS. *Lectures.*

Senior year, second term, 16 weeks, three hours per week. Required in Curriculum V. Elective in other curricula.

Assistant Professor Boyce.

Origin of the labor problem; history of labor organizations; the strike, boycott and lock-out; collective bargaining; woman and child labor; conciliation and arbitration; profit-sharing and co-operation; social insurance; labor legislation.

308. BUSINESS ORGANIZATIONS. *Lectures.*

First or second term, 16 weeks, three hours per week. Elective (305, 306).

Assistant Professor Boyce.

A study of various types of business organizations, such as the individual entrepreneur, partnership, joint stock company, pool, trust, and holding company, setting forth their advantages and disadvantages, both to the public and to those conducting the business; a constructive program for the elimination of the evil features of large corporations and the preservation of their good ones; growth and probable effect of government regulation and control.

ENGLISH AND MODERN FOREIGN LANGUAGES

Professor Barley, Assistant Professor Johnson, Mr. Henning, Mr. Cambiaire, Mr. Lloyd.

ENGLISH.

400. RHETORIC AND COMPOSITION. *Lectures.*

Freshman year, first term, 16 weeks, three hours per week. All curricula.

Assistant Professor Johnson, Mr. Henning.

A study of the theory of exposition, with especial attention to the paragraph and to the correct and effective sentence. A large amount of written work is required of the student in order that he may gain facility in the use of clear, idiomatic expression. In many instances this written work is drawn from other courses pursued by the student, thereby correlating his practice in composition with his immediate interests and activities.

401. RHETORIC AND COMPOSITION. *Lectures.*

Freshman year, second term, 16 weeks, three hours per week. All curricula (400).

Assistant Professor Johnson, Mr. Henning.

A continuation of 400.

402. ADVANCED COMPOSITION. *Lectures.*

Sophomore year, either or both terms, 16 weeks, three hours per week.

All curricula (400, 401).

Professor Barley, Assistant Professor Johnson.

This course is offered to students who prefer additional work in English composition to work in literature.

420. THE SHORT-STORY. *Lectures.*

Sophomore year, first term, 16 weeks, three hours per week. All curricula (400, 401).

Professor Barley or Assistant Professor Johnson.

An extended reading course in selected short-stories, together with a critical study of representative specimens of this literary type.

421. THE NOVEL. *Lectures.*

Sophomore year, second term, 16 weeks, three hours per week.
All curricula (400, 401).

Professor Barley.

A reading course in representative English and American novels of the nineteenth century and of the present day.

422. MASTERPIECES. *Lectures.*

Sophomore year, first term, 16 weeks, three hours per week.
All curricula (400, 401).

Professor Barley.

A critical study of selected masterpieces of the world's literature.

423. AMERICAN LITERATURE. *Lectures.*

Sophomore year, second term, 16 weeks, three hours per week.
All curricula (400, 401).

Assistant Professor Johnson.

An advanced course in the history and development of literature in the United States, with particular reference to the period following the Civil War.

The successful completion of any two of courses 402, 420, 421, 422, 423 will fulfill the requirements in English of the Sophomore year.

424. SHAKESPEARE. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
Elective (Sophomore requirements in English).

Professor Barley.

Five or six of Shakespeare's plays are carefully studied in class and several more are required as collateral reading.

425. CONTEMPORARY DRAMA. *Lectures.*

Senior year, either or both terms, 16 weeks, three hours per week.
Elective (Sophomore requirements in English).

Professor Barley.

A reading course in the drama of the present day, supplemented with lectures.

403. ENGINEERING ENGLISH. *Lectures.*

Senior year, first term, 16 weeks, two hours per week.
Elective in I, II, V, VI, VII. Required in III. (Sophomore requirements in English).

Professor Barley.

An advanced course in oral and written technical reports and in the details of engineering writing.

404. DISCUSSION AND DEBATE. *Lectures.*

Senior year, second term, 16 weeks, two hours per week.
Elective in I, III, V, VI, VII. (Sophomore requirements in English).

Professor Barley.

The primary aim of the course is to give students training in clear and logical oral expression. Topics of general and of engineering interest will be discussed and debated.

MODERN FOREIGN LANGUAGES.

The modern foreign languages offered are German, French and Spanish. Ten hours of German are required in Curriculum VII and ten hours of either German or French are required in Curriculum IV. Languages are elective in Curricula I, III, V, VI.

At present the United States Geological Survey requires German or French in its Civil Service examinations. Students who expect to qualify for this work are advised to elect one or both of these languages.

Students who expect to engage in work in Central America or South America are advised to elect Spanish.

No advanced standing will be given for high school credit in language except by examination.

450. ELEMENTARY GERMAN. *Lectures.*

Senior year, first term, 16 weeks, five hours per week.
Curriculum VII. Elective in I, III, V, VI. Optional in IV.

Mr. Henning.

451. SCIENTIFIC GERMAN. *Lectures.*

Senior year, second term, 16 weeks, five hours per week.
Curriculum VII (450). Elective in I, III, V, VI. Optional in IV (450).

Mr. Henning.

460. ELEMENTARY FRENCH. *Lectures.*

Senior year, first term, 16 weeks, five hours per week. Elective in I, III, V, VI. Optional in IV.

Mr. Cambiaire.

461. SCIENTIFIC FRENCH. *Lectures.*

Senior year, second term, 16 weeks, five hours per week. Elective in I, III, V, VI. Optional in IV (460).

Mr. Cambiaire.

470. ELEMENTARY SPANISH. *Lectures.*

Senior year, first term, 16 weeks, five hours per week. Elective in I, III, V, VI.

Mr. Cambiaire.

471. ADVANCED SPANISH. *Lectures.*

Senior year, second term, 16 weeks, five hours per week. Elective in I, III, V, VI (470).

Mr. Cambiaire.

GEOLOGY AND MINERALOGY

PROFESSOR DAKE[1], ASSISTANT PROFESSORS MUILENBURG[2], GUITERAS, AND BRIDGE, MR. DAVIDSON.

EQUIPMENT.

The geological and mineralogical laboratories are on the second floor of Norwood Hall. The equipment of the department includes reference, working and cabinet collections of minerals, ores, rocks and fossils and many specimens illustrating metallurgical processes; a working collection of wooden and glass crystal models and natural crystals; a complete set of maps and reports; a number of geological relief models, including the large relief map of the state; a large collection of thin sections of minerals and rocks, and several thousand lantern slides illustrating the topics discussed in the class room. Besides the above mentioned there are instruments for geological surveys, petrographic microscopes, and machines for trimming specimens and grinding thin sections.

There is also a set of thirty-five hundred specimens representing the mineral wealth of Missouri, consisting of coal, clays of many sorts, building stones, and ores of lead, zinc, iron, and copper, as well as gangue minerals occurring with the metalliferous deposits of the state. There is a complete collection of economic minerals of Missouri and a good collection of economic minerals representing the world at large. This collection was part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago and was presented to the School of Mines and Metallurgy by the General Assembly in 1895. Moreover, the specimens, models, and maps constituting the Missouri Mining Exhibit at the St. Louis Exposition were assigned to the school by the State Board of Equalization, thus giving the school a large amount of valuable material.

The museums contain specimens from many parts of the world. The important mining districts of the state are especially well represented by the economic collection from Southwestern Missouri, polished stone tables and ornamental stones and other complete collections from the Missouri Building at the St. Louis Exposition.

[1]Absent on leave, 1920-21.
[2]In charge of Department, 1920-21.

COURSES

501. CRYSTALLOGRAPHY. *Lectures and Laboratory.*

First year, first term, 16 weeks, 3 hours per week.
Curricula I and IV.
Text: Butler, *Geometrical Crystallography.*

Assistant Professor Muilenburg.

Elementary crystallography, including the study of models and natural crystals. The object of the course is to give the student an understanding of the general principles of crystallography and the ability to recognize crystal forms, especially the systems. The lectures are given during the regular laboratory time. This course may be taken independently or in conjunction with Petrography.

503. MINERALOGY. *Lectures and Laboratory.*

Sophomore year, first term, 16 weeks, six hours per week.
Curricula I, II, IV and VII (3 and 4).
Text: Dana, *Textbook of Mineralogy.*
Manual of Mineralogy.

Assistant Professor Guiteras.

A brief summary of the principles of crystallography as applied to the identification of minerals, followed by a thorough drill in the recognition of about one hundred and seventy-five species. Determination of unknowns by means of the blowpipe forms part of the laboratory work. The lectures are given during the regular laboratory time.

505. ROCKS AND MINERALS. *Lectures and Laboratory.*

Junior year, second semester, 16 weeks, three hours per week.
Curriculum III (3 and 4).
Text: Ries and Watson, *Engineering Geology.*

Assistant Professor Guiteras.

A study of the common ore and rock-forming minerals and types of rocks. The lectures are given during the regular laboratory time. This course is intended for Civil Engineering students, the same ground being covered more thoroughly in courses 503 and 530, so that full credit may not be had for it and either of these two, and it may not be substituted for part of them.

OPTICAL MINERALOGY.—See Geology 532.

510. GENERAL GEOLOGY. *Lectures.*

Junior year, first term, 16 weeks, three hours per week.
Curricula I and IV (503, to be accompanied by 530).
Text: Cleland, *Geology, Physical and Historical.*
Assistant Professor Bridge.

Dynamic geology. A somewhat detailed account of geologic processes. The larger topics are treated more exhaustively than in the required text. Local field trips.

512. GENERAL GEOLOGY. *Lectures.*

Junior year, second term, 16 weeks, three hours per week.
Curricula I and IV (510, to be accompanied by 513).
Text: Cleland, *Geology, Physical and Historical.*
Assistant Professor Bridge.

Introductory structural and historical geology. Typical geologic structures and their effects on the physiographical development of the earth's surface are considered for the first eight weeks. Geologic history is then traced from the beginning of the record to the present, as much attention as possible being paid to the rock systems and their contained fossils, with reference to geographic changes and organic evolution.

513. GENERAL GEOLOGY. *Laboratory.*

Junior year, second term, 16 weeks, six hours per week.
Curricula I and IV (510, to be accompanied by 512).
References: Hayes, *Handbook for Field Geologists.*
Geikie, *Structural and Field Geology.*
U. S. Geological Survey, *Prof. Paper, No.* 60.
Assistant Professor Bridge, Mr. Davidson.

Laboratory exercises in reading topographic and geologic maps, and in the construction of profile and geologic sections and simple geologic maps. These exercises are designed to illustrate the subject matter of the earlier lectures of course 512, and occupy nine weeks; excursions and field practice in elementary geologic mapping the remainder of the semester.

514. GENERAL GEOLOGY. *Lectures.*

Junior year, second term, 16 weeks, three hours per week.
Curriculum III (to be accompanied by 505).
Text: Ries and Watson, *Engineering Geology.*
Assistant Professor Bridge.

An introductory course in general geology adapted to the general needs of students in Civil Engineering. The work covers general geology with such detail as is possible in the time allowed.

516. GEOLOGY OF THE UNITED STATES. *Lectures.*

Senior year, first semester, 16 weeks, three hours per week.
Curricula I and IV (512 and 513).
Text: Blackwelder, *Handbook of Regional Geology—the United States.*

Assistant Professor Muilenburg.

The physiography and stratigraphy, economic products, and geologic history and structure of the chief geologic divisions of the United States are summarized in the lectures.

518. STRATIGRAPHIC AND METAMORPHIC GEOLOGY. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
Curricula I and IV (512, 513 and 530).

Assistant Professor Muilenburg.

An advanced course in stratigraphic and metamorphic geology, special emphasis being given to sedimentation.

520. STRUCTURAL GEOLOGY. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Curricula I and IV (512, 513 and 530).

Assistant Professor Muilenburg.

An advanced course in the study of rock deformation, including a review of the theories of the origin of the earth; a discussion of the zones of rock fracture and rock flowage, a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates and pseudo-conglomerates; and a consideration of mountain building forces, with application to special districts. The course is intended to follow 518.

521. ADVANCED GEOLOGY. *Laboratory.*

Senior year, second term, 16 weeks, six hours per week.
Curricula I and IV (512 and 513).

Assistant Professor Muilenburg.

An advanced course in the study and interpretation of topographic and geologic maps.

522. GEOLOGY CONFERENCE. *Lectures.*

Senior year, second term, 16 weeks, one hour per week.
Curricula I and IV (518 or 540).

Assistant Professor Muilenburg.

The conference consists of a discussion by the students and instructors of geologic problems and literature; each student being assigned certain work upon which he must report to the class.

530. LITHOLOGY. *Lectures and Laboratory.*

Junior year, first term, 16 weeks, three hours per week.
Curricula I and IV (503).
Text: Kemp, *Handbook of Rocks.*

Assistant Professor Guiteras.

A study of the structure, texture, mineral and chemical composition and the manner of formation and occurrences of igneous, sedimentary, and metamorphic rocks. Emphasis is placed on the megascopic character as seen with the naked eye or by aid of a hand magnifying glass, enabling the student to classify rocks in the field. The lectures are given in the regular laboratory time.

532. PETROGRAPHY. *Lectures and Laboratory.*

Senior year, first term, 16 weeks, two hours lectures and six hours laboratory per week.

Curricula I and IV (512, 513 and 530; 1002 and 1003; to be accompanied by 501).

Text: Luquer, *Minerals in Rock Sections.*
References: Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannsen, *Determination of Rock Forming Minerals.*
Weinschenk, *Petrographic Methods.*

Assistant Professor Muilenburg.

The semester is devoted to the study of optics as applied to the determination of minerals by the polarizing microscope, the identification of minerals in thin sections, and the preparation of material for microscopic study.

534. PETROGRAPHY. *Lectures and Laboratory.*

Senior year, second term, 16 weeks, two hours lectures and six hours laboratory per week.

Curricula I and IV (532).
References: Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannsen, *Determination of Rock Forming Minerals.*
Weinschenk, *Petrographic Methods.*

Assistant Professor Muilenburg.

A study of the origin, classification, and nomenclature, relations and alterations of rocks, together with the petrographic analysis

and the recalculation of the chemical analyses of rocks. The laboratory also includes the description of rock sections and making reports on examinations.

540. ECONOMIC GEOLOGY. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
Curricula I and IV (512, 513 and 530).
References: Largely to reports by the United States and State Geological Surveys.

Assistant Professor Guiteras.

A study of the origin, occurrence and distribution of the metallic ores. Various type deposits of the world are considered, special attention being given to those of the United States. Written reports are required for each district studied, reference always being made to the original reports, thus familiarizing the student with the various technical publications and their usage. The ores of the following metals are considered: Zinc, lead, copper, gold, silver, nickel, cobalt, iron, manganese, tin, mercury, tungsten, platinum and aluminum. Trips to local points of interest. Candidates for the degree of Bachelor of Science in Mine Engineering taking this course must also take the geology part of course 560, Senior Trip.

542. ECONOMIC GEOLOGY. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Curricula I and IV (512, 513 and 530).

Assistant Professor Guiteras.

A study of the origin, occurrence and distribution of the economic deposits of the non-metals. Reference is made to those technical reports which describe the most important deposits, and a written summary is required for each district studied. The subjects covered are as follows: Coal, oil and gas, clays, cements, gypsum, salt, sulphur, sulphides, building stone, abrasives, gems, soils and fertilizers. Trips to local points of interest.

Students taking this course who do not take course 560 will be given special work while the rest of the class is taking the Senior Trip.

543. FIELD GEOLOGY. *Laboratory.*

Senior year, first term, 16 weeks, six hours per week.
Curriculum I (512 and 513).

Assistant Professors Muilenburg and Bridge, Mr. Davidson.

The course consists of both field and laboratory work, the two being varied to suit the weather. The field work consists of mak-

ing topographic and geologic maps, with suitable sections and reports of assigned areas. The laboratory work includes the calculation of field notes and making maps and the final drafting of the field work. The instruments used include the plane table, hand level, aneroid barometer and telescopic alidade.

544. OIL AND GAS. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
Curriculum I (512 and 513).
References: Various treatises on oil and gas and geological reports.

Assistant Professor Muilenburg.

A detailed study of the oil and gas deposits of the United States with reference to foreign fields. The origin and occurrence of oil and gas as well as the geological and structural conditions of the various fields is taken up, followed by a study of field methods in petroleum geology.

545. OIL AND GAS. *Laboratory.*

Senior year, first term, 16 weeks, three hours per week.
Curriculum I (512 and 513; to be accompanied by 544).

Assistant Professor Muilenburg.

Laboratory work in the interpretation and preparation of production charts, geologic and structure maps.

550. PALEONTOLOGY. *Lectures and Laboratory.*

Senior year, first term, 16 weeks, one lecture and six hours laboratory.
Curricula I and IV (512).
Text: Grabau and Shimer, *Introduction to the Study of Fossils.*

Assistant Professor Bridge.

A general introduction to the study of invertebrate fossils. Emphasis is placed on the index fossils of the different periods, and on the use of paleontologic literature.

570. SPECIAL GEOLOGY.

Senior year, first or second term.
Special studies in geology, hours and subjects to be arranged with each student.

599. SENIOR TRIP.

Senior year, second term.
Curriculum I (540).

Assistant Professor Muilenburg.

During the second semester of the Senior year a trip is taken to Joplin, St. Louis, Flat River, and other points in the Missouri Lead Districts, for the purpose of studying mining, ore dressing, smelting, geology, and power plants in these districts. The geology portion of these trips is required of all candidates for the degree in Mining Engineering.

HYGIENE AND STUDENT HEALTH

ASSOCIATE PROFESSOR SHAW.

The Department of Hygiene and Student Health is under the charge of the Student Health Advisor, a physician, who keeps himself informed as to the health of the students. Each student, soon after he enters school, and thereafter as he desires, is given a careful physical examination. The result of such examination is recorded, and is used by the Department of Physical Training in determining the kind of exercise which shall be assigned to the student. Every case of illness must be immediately reported to the Student Health Advisor.

The offices and laboratories of the department are located in the basement of Parker Hall. The equipment includes an X-ray outfit. Students may receive X-ray examination without charge when, in the opinion of the Student Health Advisor, such examination is advisable.

Lectures on personal hygiene are given to all first year students. The department also offers the courses in zoology and botany which are required in Curriculum IV. Bacteriology is offered to students in Curricula IV and VII as an important subject bearing on chemical processes and on hygiene.

COURSES.

60. HYGIENE. *Lectures.*

Freshman year, first term, one hour per week.
All curricula.

Associate Professor Shaw.

61. GENERAL ZOOLOGY. *Lectures.*

Freshman year, first term, 16 weeks; 3 hours per week.
Curriculum IV.

Associate Professor Shaw.

Lectures introductory to the study of the entire field of animal life.

62. GENERAL ZOOLOGY. *Laboratory.*

Freshman year, first term, 16 weeks, six hours per week.
Curriculum IV.

Associate Professor Shaw.

Laboratory to accompany course 61.

63. GENERAL BOTANY. *Lectures.*

Freshman year, second term, 16 weeks, three hours per week.
Curriculum IV (61).

Associate Professor Shaw.

A general course presenting the fundamental features of plant life.

64. GENERAL BOTANY. *Laboratory.*

Freshman year, second term, 16 weeks, six hours per week.
Curriculum IV.

Associate Professor Shaw.

Laboratory and field work to accompany course 63.

65. GENERAL BACTERIOLOGY. *Lectures.*

Junior or Senior year, first term, 16 weeks, two hours per week.
Elective in Curricula IV and VII (Junior standing).

Associate Professor Shaw.

This course deals with general bacteriology, and with the relation of bacteria to the public health.

66. GENERAL BACTERIOLOGY. *Laboratory.*

Junior or Senior year, first term, 16 weeks, four hours per week.
Elective in Curricula IV and VII (Junior standing).

Associate Professor Shaw.

The laboratory course to accompany course 65. The work deals with the preparation of media, cultural and staining methods, diagnostic tests, and the examination of the more common bacteria.

68. MICROSCOPY OF TECHNICAL PRODUCTS. *Laboratory.*

Senior year, second term, 16 weeks, six hours per week.
Elective in Curriculum VII (62).
Text: Hanausek, Winton, *Microscopy of Technical Products.*

Associate Professor Shaw.

The microscopical examination and identification of technical materials, including the histological preparation of the sections. The work is supplemented by informal lectures in the laboratory.

LIBRARY

Harold L. Wheeler, Librarian; Mrs. Norville, Miss English, Miss Harrison.

The library occupies the second floor of Parker Hall. Its quarters consist of a large, well-lighted reading room, a stack room equipped with a double-deck Snead stack, capacity 45,000 volumes, and a suite of offices and workrooms for the library staff. All equipment is new and modern.

The collection of books numbers about 25,000 carefully selected volumes, together with a large collection of pamphlets, bulletins and reports of mining companies. The library has one of the most complete files in the middle West of American and foreign technical journals and the proceedings of scientific and engineering societies. These resources are constantly increased with reference to the different courses of study, while at the same time there is kept in view the development of a well-rounded general library. The bulk of the collection consists of works in the sciences, chiefly geology, physics, chemistry, and the useful arts, the main part of this division being engineering and mining treatises. Besides these collections, the library has the representative works of contemporary American and English literature, a good section of fiction, some biography, and the latest books of description and travel, the latter division being kept especially strong, so that the students may be informed concerning the manners and customs of the people and the characteristics of the countries into which they are likely to go to follow their vocation.

The library is a subscriber to the standard technical periodicals and the publications and transactions of societies and congresses. The leading general magazines are taken for recreational reading. The contents of the back files of this material are made available through the general periodical indexes, the engineering and mining indexes, and other bibliographic aids.

The Dewey decimal system of classification is used and the resources of the collection are made available through a full dictionary catalogue of authors, titles, and subjects.

Interlibrary loan arrangements exist between this library and the Library of Congress, the St. Louis Public Library, the John Crerar Library of Chicago, the University Library at Columbia and a number of other large libraries. By this arrangement books

not in the collection at the School of Mines may be borrowed for the use of the students for a limited time.

The reading room is open daily from 8 to 12, 1 to 6, and 7 to 10; Sunday, 2 to 5. Books and periodicals may be borrowed by all officers and students of the school, and by others having permission.

A noteworthy feature of the instruction in all departments at the Missouri School of Mines is the emphasis which is placed upon the use of the library and upon the study of engineering literature.

In connection with the Freshman English courses, the librarian gives, each year, a brief series of lectures explaining the system of classifying and the arrangement of books in the library, and the use of the catalogue and of the various collective indexes and other bibliographic aids. These lectures are supplemented by problems in the library, and by individual instruction.

MATHEMATICS

Professor Dean, Mr. Hinsch, Mr. Pritchard.

The study of mathematics is required of all regular students during the Freshman and Sophomore years. During the Junior and Senior years elective courses are offered in advanced calculus, mathematical physics and chemistry and statistical mechanics.

600. PLANE AND SPHERICAL TRIGONOMETRY. *Lectures.*

Freshman year, first term, 16 weeks, five hours per week.
All curricula.
Text: Bauer and Brooke, *Trigonometry and Tables.*
Mr. Hinsch, Mr. Pritchard.

This is a college course in trigonometry, and high school credits in Trigonometry will not be accepted in its place.

601. ANALYTICAL GEOMETRY. *Lectures.*

Freshman year, second term, 16 weeks, five hours per week.
All curricula (600).
Text: Bailey and Woods, *Analytical Geometry and Calculus.*
Professor Dean, Mr. Pritchard, Mr. Hinsch.

The object of this course is to familiarize the student with methods, rather than with any particular set of curves. Differentiation of algebraic functions.

602. DIFFERENTIAL CALCULUS. *Lectures.*

Sophomore year, first term, 16 weeks, four hours per week.
All curricula, except one option in IV (601).
Text: Bailey and Woods, *Analytical Geometry and Calculus.*
Professor Dean, Mr. Pritchard, Mr. Hinsch.

Derivation of formulae for differentials and derivatives and their application in solution of problems involving rates, velocities, accelerations, tracing of curves, maxima and minima.

603. INTEGRAL CALCULUS. *Lectures.*

Sophomore year, second term, 16 weeks, four hours per week. All curricula, except one option in IV (602).

Text: Bailey and Woods, *Analytical Geometry and Calculus.*

Professor Dean, Mr. Hinsch, Mr. Pritchard.

The principles of integration, with special stress on the forms occurring in mechanics and physics. Evaluation of areas, moments, moments of inertia, determination centre of gravity and centre of pressure. Differential equations of mechanics and physics and their application in solution of problems in physics, and mechanics.

609. ADVANCED CALCULUS. *Lectures.*

Junior or Senior year elective, 16 weeks, five hours per week (603).

Texts: Wilson, *Advanced Calculus.*
Woods and Bailey, *Mathematical Analysis,* Vol. II.
Cohen, *Differential Equations.*

Professor Dean, Mr. Pritchard.

610. MATHEMATICAL PHYSICS AND CHEMISTRY. *Lectures.*

Junior or Senior year elective, 16 weeks, five hours per week (609).

Professor Dean.

Advanced mathematical theory of heat, light, sound, electricity and magnetism, thermodynamics, thermochemistry, electrochemistry, chemical statics and dynamics. Lectures, notes and problems.

611. STATISTICAL MECHANICS. *Lectures.*

Junior or Senior year elective, 16 weeks, five hours per week (610).

Lectures, notes and problems.

Professor Dean.

Probability and least squares, kinetic theory of gases, kinetic theories in thermodynamics and chemistry, applications of Hamilton's dynamical methods, electron theory.

MECHANICAL ENGINEERING

Assistant Professor Rhoads, Assistant Professor Bowen, Mr. Underwood.

Mechanical Engineering is basic in nearly all phases of industrial activity.

The object of the department is thoroughly to train the student in the fundamental subjects of mechanical engineering, particularly as applied to mining and metallurgical work, though other work is also offered.

The work of the department is carried on in Mechanical Hall and in the mechanical laboratory of the school power plant. The equipment includes A. C. and D. C. engine and turbine generators, separate engines, turbines, air compressors, fans, pumps, condensers, boilers, and auxiliary power plant apparatus. All told, there are ten steam and internal combustion engines of various types, two steam turbines, eight centrifugal and reciprocating water pumps, five water and fire tube boilers, one centrifugal fan, and a variety of other apparatus. In addition to the regular laboratory equipment arrangements are made to use neighboring plants for power plant tests and for tests on separate boilers, engines, turbines and pumping units. There is good equipment in measuring instruments.

The forge shop is equipped with down draft forges, anvils, hand forge tools, power hammer, shears, grinding wheels, heat-treatment furnaces, automatic drill sharpener, etc.

The pattern shop is equipped with wood lathes and benches, complete sets of wood-working tools, planers, band saw, morticers, joiner, etc.

The foundry is equipped with a 28-foot cupola, core oven, ladles, and complete sets of hand-moulding tools.

The machine shop is equipped with a variety of large and small lathes, both belted and motor driven, milling machine, planers, shaper, drill presses, grinding machines, saws, vices, etc., and complete sets of machine shop tools.

In curriculum V, Mechanical Engineering, in the Senior year the student will select one of three options. The Power Plant Option is recommended for those who intend to engage in the operation or design of power plants or in the sale of power plant apparatus; the Industrial Option for those who will engage in general manufacturing, in an executive, engineering, or sales capacity; the

Milling and Smelting Option for those who expect to engage in the mechanical engineering work related to mining, milling and smelting.

Elective subjects in the several options are to be taken from the prescribed list in the curriculum. For the Power Plant and Industrial Options the electives taken must include in each term one non-technical elective. For the Milling and Smelting Option, the electives may be technical or non-technical. A modern language, if elected, must be taken through the year.

COURSES.

701. FORGE SHOP. *Laboratory.*

Freshman year, second term, 16 weeks, six hours per week.
Curricula V, VI.

Mr. Underwood.

Instruction in elementary forge work.

702. PATTERN SHOP AND FOUNDRY.
Lectures and Laboratory.

Sophomore year, first term, 16 weeks, one lecture and six laboratory hours per week.
Curricula V, VI (701).

Assistant Professor Bowen, Mr. Underwood.

Elementary pattern-making and foundry operations.

703. MACHINE SHOP. *Laboratory.*

Sophomore year, second term, 16 weeks, six laboratory hours per week.
Curricula V, VI (702).

Assistant Professor Bowen, Mr. Corey and Assistants.

Elementary machine shop work, including metal welding.

704. GENERAL SHOP METHODS. *Lecture.*

Senior year, first term, 16 weeks, three hours per week.
Curricula V (703).

Assistant Professor Bowen, Mr. Underwood.

A general study of forge, pattern, foundry and machine shop methods. Most of the time is devoted to a study of tools and methods of manufacturing various parts of machines; the balance of the time will be spent on the study of the executive work in connection with shops.

706. FOUNDRY AND FORGE SHOP METHODS.
Lectures and Laboratory.

Senior year, first term, 16 weeks, two recitations and three laboratory hours per week.

Curriculum V (702).

Assistant Professor Bowen, Mr. Underwood.

Pattern shop, foundry and forge shop methods. About half the time will be spent in study of the tools, apparatus, and methods of work in these shops; the balance of the time will be devoted to a study of the executive work in connection with these shops. The laboratory time will be used to illustrate subject matter studied in class.

707. MACHINE SHOP METHODS. *Lectures and Laboratory.*

Senior year, second term, 16 weeks, two recitations and three laboratory hours per week.

Curriculum V (703).

Assistant Professor Bowen.

A study of machine shop methods. About half the time will be spent in the study of tools, apparatus and methods of doing the actual work in machine shops; the balance of the time will be spent in study of the executive work in relation to machine shops. The laboratory time will be used to illustrate subject matter studied in class.

710. THERMODYNAMICS. *Lectures.*

Junior year, first term, 16 weeks, three hours per week.

Curriculum V (603, 606, 1002, 1003).

Text: Moyer, Caldwood & Potter, *Elements of Engineering Thermodynamics.*

Assistant Professor Rhoads.

The fundamental theories of the heat action of perfect gases, theoretical heat engine cycles, actual steam cycles, flow of steam through nozzles, and thermodynamic efficiencies.

711. HEATING AND VENTILATION. *Lectures.*

Junior year, second term, 16 weeks, two hours per week.

Curriculum V (710, 712).

Text: Harding and Willard, *Heating and Ventilation.*

Assistant Professor Rhoads.

The theory and application of the principles of heating and ventilation. The parts of the subject studied include the heat transmission in buildings; types of heating boilers, radiators and steam coils, steam, hot water and hot air heating systems, air conditioning and ventilation.

712. ELEMENTARY HEAT-POWER APPARATUS.
Lectures and Laboratory.

Junior year, first term, 16 weeks, three recitations and three laboratory hours per week.

Curriculum V (accompanied by 710).

Text: Kent, *Steam Boiler Economy.*

Assistant Professor Rhoads.

The theory, thermodynamic and mechanical principles of elementary heat-power apparatus. Boilers are studied with re-respect to type, fuels, combustion, feed water, economies and principles of operation. Steam engines are studied with respect to type, steam action, valve gears, governing, testing, economies, and mechanical forces acting in the machines. The laboratory work will deal chiefly with the testing and calibration of auxiliary power apparatus.

713. INTERNAL COMBUSTION ENGINES.
Lectures and Laboratory.

Junior year, second term, 16 weeks, three recitations and three laboratory hours per week.

Curriculum V (710, 712).

Assistant Professor Rhoads.

The theory, thermodynamic and mechanical principles of internal combustion engines. The thermodynamics, theoretical and actual cycles of operation, ignition, valve gears, governing, testing, economies, and mechanical forces acting in various gas and oil engines will be studied. Gas producers will be studied from a heat and mechanical basis. In the laboratory tests will be run on internal combustion engines, steam engines and boilers.

714. MECHANISMS. *Lectures and Laboratory.*

Junior year, first term, 16 weeks, two recitations and three laboratory hours per week.

Curricula V, VI (603, 606, 1002, 1003).

Text: Keown, *Mechanisms.*

Mr. Underwood.

The kinematic and elemental force-actions in simple mechanisms. The subjects dealt with include motions, velocities, velocity diagrams, acceleration, instantaneous centers, cams, gearing and belting. The laboratory period will be devoted to the solution of problems by drawing mechanisms which will satisfy given kinematic requirements.

715. ELEMENTARY MACHINE DESIGN.
Lectures and Laboratory.

Junior year, second term, 16 weeks, two recitations and three laboratory hours per week.

Curricula V, VI (714).

Text: Leutweiler, *Machine Design.*

Assistant Professor Rhoads.

The elementary design of common machine parts, including choice of materials and the designing of couplings, springs, shafting, belting, pulleys and simple spur and bevel gears.

720. COMPRESSED AIR. *Lectures and Laboratory.*

Senior year, first term, 16 weeks, three recitations and three laboratory hours per week.

Curriculum V (605, 606, 710, 712).

Text: Harris, *Compressed Air.*

Professor Harris.

A study of the theory of air compression in reciprocating and centrifugal machines and of the measurement and transmission of compressed air, and its application in industrial work. In the laboratory tests will be made on the centrifugal and reciprocating air machines, on pipe friction and orifice calibration and time will also be devoted to the solution of practical problems illustrating the application of compressed air theory.

721. STEAM TURBINES. *Lectures and Laboratory.*

Senior year, second term, 16 weeks, three recitation and three laboratory hours per week.

Curriculum V (710, 712, 713).

Assistant Professor Rhoads.

The theory, thermodynamic and mechanical principles of the steam turbine, types of turbines, thermodynamic action, and steam flow. In the laboratory tests will be made on turbines, condensers and other auxiliary apparatus.

722. ADVANCED MACHINE DESIGN. *Laboratory.*

Senior year, first semester, 16 weeks, six hours per week.

Curricula V, VI (714, 715).

Text: Leutweiler, *Machine Design.*
Notes.

Assistant Professor Rhoads.

This course offers work in the design of machine parts more difficult than those given in 715 and in the design of complete simple

machines. The problems taken up will include such parts as clutches, spur, bevel and worm gears, bearings, connecting-rods, presses and shears.

723. POWER PLANT AUXILIARY APPARATUS. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Curriculum V (710, 712, 713, 721).
Texts: Harding and Willard, *Power Plants.*
Kent, *Steam Boiler Economy.*
Assistant Professor Rhoads.

A study of the auxiliary apparatus used in steam and internal combustion engine power plants, including pumps, feed water heaters, economizers, stokers, coal and ash handling systems, condensers and auxiliaries, cooling towers and ponds, valves, pipes and piping systems.

725. PLANT DESIGN. *Laboratory.*

Senior year, second term, 16 weeks, six hours per week.
Curriculum V (accompanied by 723).
Texts: Harding and Willard, *Power Plants.*
Harding and Willard, *Heating and Ventilation.*
Kent, *Steam Boiler Economy.*
Assistant Professor Rhoads.

The design of simple plants for industrial and other purposes. The problems will include heating and ventilating systems, selection and layout of machinery and line shafting, design of an internal combustion engine plant, and a complete steam power plant for electric light, water, and power service.

727. REFRIGERATION. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Curriculum V (710, 712).
Assistant Professor Rhoads.

A study of the theory and application of refrigeration, including the mediums, processes, and mechanical principles of refrigerating machines, the types of ice and cold storage systems, refrigerating building insulation, pipes, piping systems, valves, and auxiliary refrigerating apparatus.

728. HYDRAULIC TURBINES. *Lectures.*

Senior year, first term, 16 weeks, two hours per week.
Curriculum V (131).
Assistant Professor Rhoads.

The theory and principles of hydraulic turbines, including the theory of operation, types, governing, operating characteristics, and design of hydraulic turbines.

729 SEMINAR. *Lectures.*

Senior year, second term, 16 weeks, two hours per week.
Curriculum V.
Text: *Current Technical Literature.*

Assistant Professor Rhoads.

A study of modern mechanical apparatus. The work will consist each week of a paper presented by a member of the class on a subject in his particular field of study.

770. POWER PLANTS. *Lectures and Laboratory.*

Junior or Senior year, first term, 16 weeks, three recitations and three laboratory hours per week.
Curricula I, II, VI, VII (603, 604, 1002, 1003).

Assistant Professor Rhoads.

A study of power plants in general. The work will include steam boiler types, fuels, combustion principles, the steam engine, elementary thermodynamics, valve gears, governing, indicating, testing, economies and operation. In the laboratory the work will include the testing and calibration of minor power plant apparatus and simple engine testing.

771. POWER PLANTS. *Lectures and Laboratory.*

Junior or Senior years, second term, 16 weeks, three recitations and three laboratory hours per week.
Curricula I, II, VI, VII (770).

Assistant Professor Rhoads.

A continuation of course 770. The work will include steam turbines, internal combustion engines, gas producers and auxiliary apparatus. In the laboratory tests will be made on boilers, engines, turbines and auxiliary apparatus.

790. WORK IN PRACTICE.

Summer vacation following the Junior year.
Required in Curriculum V.

To receive a degree in Mechanical Engineering, the student (a) must have worked not less than twelve weeks in some industrial plant; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some industrial plant designated by the head of the department; or (c) a regularly supervised inspection trip may be taken in place of this practice work or observation, provided such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

796. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Elective.

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to the specifications described on page 34.

MECHANICS

PROFESSOR GARRETT.

651. THEORETICAL MECHANICS. *Lectures.*

Sophomore year, second term or Junior year, first term, 16 weeks, three hours per week.

Curricula I, II, III, V, VI, VII (602).

Text: Poorman, *Applied Mechanics.*

Professor Garrett.

652. MECHANICS OF MATERIALS. *Lectures.*

Junior year, first or second term, 16 weeks, three hours per week.

Curricula I, II, III, V, VI, VII (651).

Professor Garrett.

653. MATERIALS LABORATORY. *Laboratory.*

Junior year, first or second term, 16 weeks, three hours per week.

Curricula I, II, III, V, VI, VII (651; to accompany 652).

Professor Garrett.

Includes the study of testing machines and strain-measuring apparatus; and physical tests in tension, compression, fixure and torsion of cast iron, wrought iron, structural steel, timber, etc., laboratory and computing-room periods.

654. ADVANCED THEORETICAL MECHANICS. *Lectures.*

Junior or Senior elective, 16 weeks, three hours per week.

Professor Garrett.

A continuation of course 651, giving special attention to dynamos, with technical applications.

655. ADVANCED MECHANICS OF MATERIALS. *Lectures.*

Junior or Senior elective, 16 weeks, three hours per week.

Professor Garrett.

This course begins with a more advanced study of certain parts of the work covered in 652, and includes a further discussion of such subjects as combined stresses, inertia circle and ellipse, kern, beams of unsymmetrical section, curved beams, flat plates and thick cylinders.

METALLURGY AND ORE DRESSING

PROFESSOR CLAYTON, MR. BAINS, MR. THORNBERRY.

The assay laboratory includes the furnace room, the parting room and the balance room. In the furnace room are twenty coal-fired double-muffle furnaces, twelve gasoline-fired furnaces and ten coke-fired furnaces. The balance room contains twenty-four balances suitable for weighing gold. The parting room contains the necessary hot plates and annealing muffles.

There is, in the main furnace room, a circular water-jacket blast furnace 20 inches in diameter at the tuyeres and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster and an experimental zinc distilling furnace.

The pyrometry laboratory is well equipped with various types of instruments suitable for measuring temperatures up to 3,000 degrees F. Two Leeds and Northrup recording potentiometers, one indicating potentiometer, one Wilson-Maulin tapalog, and several millivoltmeters constitute the instruments suitable for measuring temperatures up to 2,700 degrees F. Both base metal and noble metal couple with compensating leads can be used interchangeably on the double-range instruments.

A Wanner optical pyrometer and a Leeds and Northrup optical pyrometer will measure the highest attainable temperature.

Electric furnaces capable of attaining temperatures up to 3,600 degrees F. are used for melting metals for standardizing the various pyrometers.

The metallography laboratory, equipped with horizontal polishing machines, Bausch and Lomb metallurgical microscopes and one inverted microscope, furnishes ample facilities for a complete study of metals and their alloys. Some 500 specimens form an interesting collection for showing the effect of mechanical and thermal treatment on ferrous and non-ferrous alloys.

It is recognized that the school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim to give such training in the fundamental principles and their application that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

The ore sample room is well stocked, containing about one thousand samples, all carefully prepared and assayed. The samples are characteristic ores and metallurgical products such as mattes, bullions, cyanide solutions, fume, etc.

The equipment of the ore dressing laboratory includes, in the crushing and sampling department, a gyratory breaker, a Dodge breaker, a pair of 9-inch by 12-inch rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests there is provided a three-stamp mill, with amalgamation plates.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely-crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, one Deister-Overstrom table, and Diester Plat-O sand table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected motor-driven centrifugal sand pumps are used for elevating finely-crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a small gyratory breaker, a disc grinder, a coffee mill, a pair of rolls, a number of bucking boards and mullers, a laboratory tube mill, a Ro-Tap testing sieve shaker and an electric sampler dryer.

Ores suited to a magnetic concentration are treated on a Knowles magnetic separator.

The equipment of the flotation laboratory is complete and modern. It includes eight machines of the mineral separation type, four of which are of the modified air-life type, one Janney machine (the gift of D. C. Jackling), and one Callow machine. Each machine is arranged so that it can be run independently of all others or in combination.

COURSES.

801. FIRE ASSAYING. *Lectures.*

Sophomore year, second term, 16 weeks, two hours per week.

Required in I and II (503).

Texts: Fulton, *Assaying.*

Smith, *Sampling and Assaying of the Precious Metals.*

Professor Clayton, Mr. Bains.

The theory of fire assaying, by scorification and crucible methods, of ores and metallurgical products.

802. FIRE ASSAYING. *Laboratory.*

Sophomore year, second term, 16 weeks, six hours per week. Required in I and II (801).

Professor Clayton, Mr. Bains.

In this laboratory work ores and metallurgical products are assayed by fire and by combination methods. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying, the student studies the losses occurring. The laboratory is so arranged that a student learns to handle a large amount of work with the best utilization of his time and with the accuracy demanded by best practice.

804. FIRE ASSAYING. *Laboratory.*

Sophomore year, second term, 16 weeks, three hours per week. Elective in VII (801).

Professor Clayton, Mr. Bains.

Covers more briefly the work outlined in course 802.

805. INTRODUCTORY METALLURGY.

Lectures and Laboratory.

Junior year, first term, 16 weeks, one recitation hour and six laboratory hours per week.

Required in II (801, 802).

Professor Clayton.

This course will be given for the students in the Metallurgy curriculum and will serve as an introduction to general metallurgical practice. The work in the laboratory will teach the student the practice of sampling, leaching, fuel testing, temperature measuring, etc. In the classroom verbal and written reports will be made on all experiments.

807. PRINCIPLES OF METALLURGY. *Lectures.*

Junior year, second term, 16 weeks, three hours per week. Required in I and II (503, 801, 802, 1002, 1003).

Texts: Fulton, *Principles of Metallurgy.*
Hoffman, *General Metallurgy.*

Professor Clayton.

This course is an introduction for the advanced metallurgical courses. The work is covered in a general way by the following headings: The properties of metals; the chemical equation from the standpoint of the metallurgist; methods of combustion; the temperature of combustion in any system and the effect thereon of certain variables; measurement of high temperatures; means of supplying oxygen for combustion, including stack design; metallurgical fuels and methods of firing, including a study of coals, coke, charcoal, gases from producers, and liquid fuels; calorimetry; refractories and their uses, types of furnaces and the reasoning involved in their design; a general study of typical metallurgical operations, including pyrometallurgical, hydrometallurgical and electrometallurgical processes; slags in general; conduction, radiation, and convection from the standpoint of the metallurgist. In this course much attention is given to the methods of attacking various metallurgical problems.

808. PRINCIPLES OF METALLURGY. *Laboratory.*

Senior year, first term, 16 weeks, three hours per week.
Required in I (801, 802, 807).

Professor Clayton.

Application of the principles discussed in course 807.

809. METALLURGY OF IRON AND STEEL. *Lectures.*

Junior year, second term, 16 weeks, three hours per week.
Required in II (807).
Texts: Stoughton, *Metallurgy of Iron and Steel.*
Howe, *Metallurgy of Cast Iron and Steel.*
Richards, *Metallurgical Calculation.*

Professor Clayton.

Intended primarily for those following metallurgy. A detailed study of iron and steel, production, thermal treatment and metallography.

810. METALLURGICAL CALCULATIONS. *Laboratory.*

Junior year, second term, 16 weeks, three hours per week.
Required in II (to accompany 807).

Professor Clayton.

The problems given in this course are the common ones that the metallurgist meets in practice.

811. METALLURGY OF THE NON-FERROUS METALS. *Lectures.*

Senior year, first term, 16 weeks, four hours per week.
Required in II, elective in I (807).

Professor Clayton.

The greater part of the time is devoted to the metallurgy of copper, zinc, lead, gold and silver; but consideration is also given to tin, antimony and aluminum.

812. METALLURGY OF THE NON-FERROUS METALS. *Laboratory.*

Senior year, first term, 16 weeks, three hours per week.
Required in II, elective in I (807 and 808, or 805 and 811).

Professor Clayton.

Aims not only to show the practical application of the principles outlined in course 811, but also to prove the statement that "Each ore is a problem in itself."

813. METALLURGY OF THE NON-FERROUS METALS. *Lectures.*

Senior year, second term, 16 weeks, four hours per week.
Elective in II, I (807, 811).

Professor Clayton, Mr. Bains.

A continuation of course 811.

814. METALLURGY OF THE NON-FERROUS METALS. *Laboratory.*

Senior year, second term, 16 weeks, three hours per week.
Elective in I and II (807, 811, 813).

Professor Clayton, Mr. Bains.

A continuation of course 812.

821. ELECTRO-METALLURGY. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Elective in II (807, 811, 1050, 1052).

Mr. Bains.

A study of all metallurgica operations in which electricity plays a part, either electrolytically or electrothermically. Efficiency calculations based on these processes are given.

822. ELECTRO-METALLURGY. *Laboratory.*

Senior year, second term, 16 weeks, six hours per week.
Elective in II (807, 811; to accompany 821).

Mr. Bains.

831. ORE DRESSING. *Lectures.*

Senior year, first term, 16 weeks, three hours per week.
Required in I and II (807).

Mr. Bains.

The principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances. The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

832. ORE DRESSING. *Laboratory.*

Senior year, first term, 16 weeks, three hours per week.
Required in I, elective in II (to accompany 831).

Mr. Bains.

The student becomes familiar with the operations and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

833. ORE DRESSING. *Lectures.*

Senior year, second term, 16 weeks, three hours per week.
Required in I, elective in II (831, 832).

Mr. Bains.

A continuation of course 831.

834. ORE DRESSING. *Laboratory.*

Senior year, second term, 16 weeks, three hours per week.
Required in I, elective in II (to accompany 833).

Mr. Bains.

836. ORE DRESSING PROBLEMS. *Laboratory.*

Senior year, second term, 16 weeks, six hours per week.
Elective in I, II (831, 832).

Professor Clayton, Mr. Bains.

The design of ore dressing machinery and plants. The course includes the determination of a practical process for treating a given ore, and the design for a mill for utilizing this process.

861. METALS IN ENGINEERING. *Lectures.*

Senior year, first term, 16 weeks, two hours per week.
Required and permitted only in III, V, VI, in Senior year.
Professor Clayton.

A short course in metallography, devoted to the study of physical metallurgy as it is important to the users of metals, engineers and constructors in general.

863. ALLOYS AND METALLOGRAPHY. *Lectures.*

Senior year, first term, 16 weeks, two hours per week.
Required in II and IV, elective in VII (807, 809).
Professor Clayton.

These lectures deal with the theoretical and practical considerations that influence the structures and properties of metals and alloys.

864. ALLOYS AND METALLOGRAPHY. *Laboratory.*

Senior year, first term, 16 weeks, six hours per week.
Required in II and IV, elective in VII (must accompany 863).

In addition to the usual microscopic examination of metals this course includes the use of the X-ray in metallography.

Professor Clayton.

865. ALLOYS AND METALLOGRAPHY. *Lectures.*

Senior year, second term, 16 weeks, two hours per week.
Required in II (863, 864).
A continuation of course 863.

Professor Clayton.

866. ALLOYS AND METALLOGRAPHY. *Laboratory.*

Senior year, second term, 16 weeks, three hours per week.
Required in II (863, 864, 865).

Professor Clayton.

890. WORK IN PRACTICE.

Summer vacation following the Junior year.
Required in II.

To receive a degree in Metallurgy, a student (a) must have worked not less than twelve weeks in some metallurgical industry or plant; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some metallurgical plant designated by the head

of the department; or (c) a regularly supervised inspection trip may be taken in place of this practice work or observation, provided that such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

896. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Elective in II (807, 809, 811, 813).

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to the specifications described on page 34.

899. SENIOR TRIP.

Senior year, second term.

Required in II.

During the second term of the Senior year, a two weeks' trip is taken either to the Joplin district, or to Flat River and other points in the southeast Missouri lead district, for the purpose of studying ore dressing, smelting, metallurgical and power plants in these districts.

MILITARY SCIENCE AND TACTICS

First Lieutenant Peckham, Master Sergeant Scott, Staff Sergeant Palmer.

The War Department maintains at the Missouri School of Mines an Engineer Unit of the Senior Division, Reserve Officers' Training Corps.

Military Science and Tactics is required of all physically fit Freshmen and Sophomores and may be elected by Juniors and Seniors. If a student joins the R. O. T. C., the War Department will furnish his uniform and equipment. If he does not join the R. O. T. C., he must buy his own uniform.

Students electing R. O. T. C. work must do so for two years at a time. The first election is for the two-years' basic course, after which, if the student is recommended for further training, he may elect the advanced course for the remainder of the college course. During the last two years, if he elects the advanced course and attends one of the Senior advanced camps described below, he receives commutation of subsistence amounting to about $16.00 a month.

The R. O. T. C. Unit at the Missouri School of Mines is organized as a battalion of two companies, and the cadet officers are selected, as far as possible, from the members of the two upper classes who have elected to take the advanced course.

Each year, upon the completion of the advanced course, students qualified for commissions in the Officers' Reserve Corps are selected by the Director of the School and the Professor of Military Science and Tactics. The President of the United States, under such regulations as he may prescribe, is authorized to appoint these men as reserve officers of the Army of the United States.

TRAINING CAMPS

One or more R. O. T. C. Engineer Camps are held during the summer. They ordinarily open about the middle of June and continue for a period of six weeks. In the summer of 1920 this camp was held at Camp A. A. Humphreys, Va.

The Senior basic camp is attended normally at the end of the first year of the basic course and attendance is voluntary on the part of the student. The Senior advanced camp is attended normally at the end of the first year of the advanced course (Junior year); but, under certain conditions, it may be attended at the end of the Sophomore or Senior year. Attendance at the advanced

camp is compulsory for those students who elect the advanced course and receive commutation of subsistence.

Transportation, subsistence, uniforms, equipment, and medical attendance are furnished members of the R. O. T. C. attending summer camps. In addition to these allowances, students are paid at the rate of $30.00 a month while attending advanced course camps. The period of instruction at camps is properly divided between training in the fundamental military subjects and training in the special technical subjects with which the military engineer is concerned.

COURSES

The course as outlined has for its primary object the training of engineering students, so that, at the termination of their instruction, they will possess the following essential characteristics of a well-balanced junior officer of Engineers:

(a) A good general education.

(b) A good engineering education.

(c) A well-disciplined body and mind.

(d) A basic military training and a knowledge of the practical application of engineering principles and methods to military operations.

The first two characteristics are attained by following the regular college courses. The attainment of the third characteristic is reached by a combination of training on the drill ground, in the lecture room and gymnasium, and at the training camps. The fourth is attained by instruction in those phases of military education and training which are fundamental and common to all arms, as well as in those of a technical nature which pertain primarily to engineering in war.

The law requires an average of three hours per week per academic year for military training during the basic course and five hours per week during the advanced course if the student draws commutation. During two of these five hours the student is taking engineering courses of military value in departments other than that of Military Science and Tactics, so that the student actually spends three hours per week under the Department of Military Science and Tactics throughout the four academic years.

In the military department the different subjects interlock and are arranged in accordance with the weather conditions. Therefore, the two terms are not segregated.

M 1. MILITARY.

Freshman year, first and second terms, 32 weeks, three hours per week.

Required in all curricula.

Lieutenant Peckham, Sergeants Scott and Palmer.

Organization; discipline, military courtesy, customs of the service, military uniforms, insignia, colors; military hygiene; infantry drills, ceremonies, small arms, gallery practice, physical exercises; principles of military law, articles of war; security on the march and in camp, interior guard duty, field messages; military map reading and map making.

M 2. MILITARY.

Sophomore year, first and second terms, 32 weeks, three hours per week.

Required in all curricula (M 1).

Lieutenant Peckham, Sergeants Scott and Palmer.

Organization; morale; voice, methods of instruction, infantry drills, ceremonies, small arms, pistol practice, physical exercises; security on the march and in camp, interior guard duty, orders and reports, characteristic tactics of various arms; road and position sketching; field fortifications; military bridges, roads and railways, cordage and rigging; engineer organization; military policy.

M 3. MILITARY.

Junior year, first and second terms, 32 weeks, three hours per week.

Elective in all curricula (M1, M 2).

Lieutenant Peckham.

Administration; morale; military hygiene; infantry drills, ceremonies; riot duty, rules of land warfare; security, reconnaissance, tactics; aerial photographs, aerial mapping, map reproduction; fortifications, camouflage, demolitions, military explosives, mine warfare; seacost fortifications; motor trucks, tractors, trailers, tanks, armored cars, heavy artillery, railway artillery; engineer organization.

M 4. MILITARY.

Senior year, first and second terms, 32 weeks, three hours per week.

Elective in all curricula (M 1, M 2, M 3).

Lieutenant Peckham.

Supply; customs of the service; camp sanitation; infantry drills, ceremonies, hippology; courts-martial, martial law, military government; engineer troops in combat, engineer operations; coast defenses and the navy—their relation to each other and to national policy; military bridges; general construction; electrical equipment; the Corps of Engineers and its duties in peace and in war; military history and policy.

MINING

Professor Forbes, Mr. Weigel.

The mining lecture room is located on the first floor of Norwood Hall, in the southwest corner of the building. This room contains a number of mining exhibits, including mine models, several rock drills in section, rock drill bits, wire ropes, safety lamps, mine-rescue apparatus and various other mining appliances. A lantern and reflectoscope is provided in the class room and the department has several hundred slides of mining scenes and mining machinery.

A number of models illustrating mining methods, head frames, mine timbering, skip dumps, reversible mine fan and a rotary drill for coal mining, are on display in the mining laboratory, and are used in connection with the lecture work.

The surveying equipment, already referred to under Civil Engineering, includes a number of mining transits with auxiliary telescopes, which are used for field work in mine surveying.

LABORATORIES

To meet the needs of some of the more important phases of mining work four laboratories have been equipped as follows:

Mine-Rescue and First-Aid Laboratory.—The equipment of this laboratory consists of three helmets, a Draeger, a Fleuss and a Westfalia, and all necessary first-aid supplies and charts.

The instruction in Mine-Rescue and First-Aid is given by representatives of the U. S. Bureau of Mines, from one of their mine-rescue cars.

Rock-Drilling Laboratory.—On account of the importance of rock drilling in metal mining, and also because it can readily be carried on in the laboratory, much stress is laid on this branch of the work. The drilling equipment consists of three piston drills and six hammer drills, including the mounted type or Water Leyner, the jack-hammer type and stopers.

For experimental work in drilling, large blocks of red granite are imported from southeast Missouri. For supporting the machines when mounted on columns, two drilling frames have been constructed. For drilling up-holes with the stopers, a concrete-lined pit has been excavated, over which is placed a large block of granite, supported on stringers.

For sharpening steel, besides the usual hand tools, there is a Leyner-Ingersoll 5A sharpener, with a complete assortment of dies

and dollies for forming various-shaped bits, as well as parts for shanking Leyner, jack-hammer and piston steels.

The work done in this laboratory is largely experimental work, and includes investigations concerning rock-drill bits and drill steel and measuring air consumption of drills.

Compressed-Air Laboratory.—A Sullivan WB-2 straight-line air compressor of 290 cubic feet capacity, supplies air for this laboratory as well as for the rock-drilling laboratory.

Two large displacement tanks, 15 feet high and 5 feet in diameter, are used for making accurate measurements of air for the determination of orifice coefficients and for various other experiments. Another interesting installation in this laboratory is a mine fan. This is a 36-inch, single-inlet "Sirocco," directly connected to a 35-H. P. variable speed motor, and has a capacity of 20,000 cubic feet per minute, against a 4-inch water gauge. Two styles of runners, with vanes at different angles are provided for experimental work. The fan is used in the regular laboratory work, where its efficiency is determined under varying conditions, and also for experimental work in air measurements.

EXPERIMENTAL MINE

In order to provide a laboratory where practical instruction in mining and mine surveying can be given, the school has equipped a small experimental mine. This mine is located about one and one-half miles from the school, at the site of an old dolomite quarry, where a tunnel has been driven into a hillside. The main tunnel is about 100 feet in length, 50 feet of which is timbered. Branch drifts have been run from each side of the tunnel, making a total of 350 feet of underground openings. A small shaft, about 20 feet deep, connects the main tunnel with the surface. It is planned to construct a head frame and ore pocket over this shaft during the present year. Rock will be hoisted from the tunnel, loaded into the ore pocket and afterward hauled into town for use on the roads.

The power plant for running the machine drills used in the mine, consists of a 50-H. P. fire tube boiler and an Imperial, type 10, Rand air compressor of 100 cubic feet capacity, and a Laidlow-Dunn-Gordon air compressor of 100 cubic feet capacity. Water for the boiler and drills is pumped from a nearby stream, with a centrifugal pump, driven by a 3-H. P. Fairbanks-Morse gasoline engine.

In designing the power plant, an endeavor was made to introduce as great a variety of machinery as possible, as the operation of the plant is considered one of the most valuable features of this work.

The laboratory work done at the experimental mine consists largely of drilling, blasting and mine surveying. In addition to this, some work is given in sharpening steel, timbering, mucking, track-laying, hand-drilling and running the power plant. This affords a greater variety of work than can ordinarily be obtained in a reasonable length of time in practice. It is not the aim in this work to make drill runners or miners out of students, but to give them a greater familiarity with mining tools and methods than is obtainable from books and mere observation.

COURSES

900. MINE AND RAILROAD SURVEYING. *Lectures.*

Junior year, first term, 16 weeks, three hours per week.
Curriculum I (102).
Text: Peele, *Mining Engineers' Handbook.*

Professor Forbes.

The theory and practice of mine surveying are presented by lectures. The methods of carrying azimuth underground are studied in detail, including shaft plumbing and the use of the auxiliary telescope. Problems involving the strike and dip of veins are introduced, including the determination of intersection of veins, length of tunnels to intersect veins at depth, and the determination of strike, dip and thickness of veins from bore hole data.

About one-third of the time is devoted to railroad surveying, studying the theory of simple, compound and reverse curves, frogs and switches, turnouts and cross-overs and earthwork.

901. MINE AND RAILROAD SURVEYING. *Laboratory.*

Junior year, first term, 16 weeks, six hours per week.
Curriculum I (102, to be accompanied by 900).

Professor Forbes, Mr. Weigel.

In this course the original field notes of complete metal mine and coal mine surveys are given to the student, from which he works up the complete records for the mine office, including latitudes and departures and the finished mine maps.

Practical work in mine surveying at the school mine, is also a part of this course. Each student is required to make a complete survey of the experimental mine, plumbing the shaft with two wires and also using the auxiliary telescope. Complete notes of this survey, together with a map of the mine are required.

About one-fourth of the time is devoted to practice in railroad surveying.

903. MINING LABORATORY.

Junior year, first term, 16 weeks, three hours per week.
Curriculum I (to be accompanied by 900).

Professor Forbes.

Practical work in rock-drilling and blasting, timbering, sharpening steel, track-laying, mucking and operating of mine power plant. Written reports are required on all work. The course in Mine-Rescue Work, given by the United States Bureau of Mines is a required part of this laboratory.

904. MINING. *Lectures.*

Junior year, second term, 16 weeks, four hours per week.
Curriculum I (903, 1002).
Texts: Peele, *Mining Engineers' Handbook.*
Current Technical Journals.
Publications of U. S. Bureau of Mines.

Professor Forbes.

A study of rock excavation, including rock drilling, explosives and blasting, supporting excavations, tunneling and shaft sinking, hoisting and haulage.

906. MINING. *Lectures.*

Senior year, second term, 16 weeks, four hours per week.
Curriculum I (904, 540).
Texts: Peele, *Mining Engineers' Handbook.*
Current Technical Journals.

Professor Forbes.

This course is a continuation of the work of the Junior year and includes the study of prospecting, sampling and estimation of ores, mine valuation, mining costs and mining methods. The principles of mining law are also reviewed.

Students taking the course who do not take Course 907, Senior Trip, will be given special work while the remainder of the class is taking the Senior Trip.

908. COAL MINING METHODS AND VENTILATION. *Lectures.*

Senior year, first term, 16 weeks, four hours per week.
Curriculum I, Coal Mining Option (904, 1002).
Texts: Beard, *Mine Gases and Ventilation.*
Current Technical Journals.

Professor Forbes, Mr. Weigel.

A detailed study of coal mining methods and ventilation. A large part of the course is devoted to problems in mine ventilation.

910. MINE AND MILL DESIGN. *Lectures and Laboratory.*

Senior year, first term, 16 weeks, two hours lectures and six hours laboratory per week.

Curriculum I (604, 605).

Text: Ketchum, *Design of Mine Structures.*

This course covers the graphic and analytic methods of determining stresses in the simpler engineering structures used in mining.

911. MINE AND MILL DESIGN. *Laboratory.*

Senior year, second term, 16 weeks, six hours per week.

Curriculum I (910).

This course is a continuation of course 912 and covers the complete design, with estimates and bills of materials, for the complete equipment of a given mine or mill.

912. PRINCIPLES OF MINING. *Lectures.*

Junior year, first term, 16 weeks, three hours per week.

Curriculum II (1002).

Text: Peele, *Mining Engineers' Handbook.*

A special course in mining for metallurgists, designed to acquaint them with mining methods and conditions, so that they may be better fitted to co-operate with the mine management.

920. OIL PRODUCTION METHODS. *Lectures.*

Junior or Senior year, second term, 16 weeks, three hours per week.

Curriculum I (Petroleum Engineering and Oil Geology Options) (1002).

Texts: Paine and Stroud, *Oil Production Methods.*
U. S. Bureau of Mines; *Bulletins; Technical Papers.*
Current Technical Journals.

A study of well-drilling and oil-production methods.

921. OIL MAPPING AND GRAPHIC CHARTS. *Laboratory.*

Senior year, second term, 16 weeks, three hours per week.

Curriculum I (Petroleum Engineering and Oil Geology Options) (544).

Mr. Woolrych.

This is a drafting room course that includes a study of methods used by the large producing oil companies in their engineering and statistical departments. The work consists of making oil maps, graphic charts, and valuation curves.

990. WORK IN PRACTICE.

Summer vacation following Junior year.

Required in Curriculum I.

To receive a degree in the mining course, the student (a) must have worked not less than twelve weeks at some mine, mill or smelter, or have been engaged in geological or other work recognized as being along mining lines; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching at some mine or mill designated by the department; or (c) a regularly supervised inspection trip may be taken in place of this practice work or observation, provided such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

996. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Elective in Curriculum I.

Professor Forbes.

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to the specifications described on page 34.

999. SENIOR TRIP.

Senior year, second term.

Curriculum I. Professor Forbes.

During the second semester of the Senior year, a two-weeks' trip is taken either to the Joplin district, or to Flat River and other points in the southeast Missouri lead district, for the purpose of studying mining, ore dressing, smelting, and power plants in these districts. Students specializing in coal mining may visit the Illinois coal fields and those specializing in petroleum engineering may visit the Oklahoma oil fields, in place of taking the trip as above outlined.

PHYSICAL TRAINING

Associate Professor Dennie, Assistant Athletic Director McCune.

For the physical training of students excellent opportunities are offered by the Jackling Gymnasium and the Jackling Field. The former, completed in 1915, at a cost of seventy thousand dollars, is a strictly modern fireproof building and is equipped with baths, dressing rooms, lockers, a swimming pool 20 feet wide and 60 feet long and various kinds of apparatus and game courts usually found in modern gymnasiums. Class work, consisting of setting-up exercises, developing exercises, calisthenics, the use of dumb-bells, clubs, and wands is given under the supervision of the Director of Physical Training. Instruction in swimming, boxing and wrestling is also given, the aim of this work being to develop health, strength, vitality and cohesion of movement.

Jackling Field, constructed in 1909, by virtue of a gift of Mr. D. C. Jackling, '92, adjoins the Gymnasium and provides a football gridiron, a baseball diamond, and a quarter-mile running track for class and intercollegiate games and events. A number of tennis courts about the campus are maintained in good order. Golf links near the campus are maintained for the benefit of the students.

The school encourages rational athletics and a participation in intra- and intercollegiate sport, all branches of which are under the direct supervision of the Director of Physical Training and management of the Board of Control. The membership of the Board of Control consists of the Director of Physical Training, the Chairman of the Faculty Committee on Athletics, the President and Student Manager of the Athletic Association, and the Secretary of the Executive Committee of the Board of Curators as ex officio treasurer.

The personnel of the Board of Control for 1921-22 comprises Professor Dennie, Professor Barley, Mr. Bailey, Mr. Jewell and Mr. Kahlbaum.

Physical exercises in military drill and gymnasium are required of all physically fit Freshmen and Sophomores. A student who is physically unfit for military drill may, upon the advice of the Director of Student Health, substitute special work in the Gymnasium for the regular exercises.

During the first term, Freshman year, fifteen lectures in hygiene are given and one hour a week is devoted to setting-up exercises. During the second term, two hours a week are devoted to exercises with dumb-bells and chest weights.

During the Sophomore year two hours a week are devoted to exercises with wands, Indian clubs and chest weights, and to indoor games and apparatus work.

COURSES

PE 1. HYGIENE. *Lectures.*

Freshman year, first term, 16 weeks, one hour per week.
Associate Professor Shaw.

All curricula.

Lectures in the care and use of the body based upon modern researches. The chief aim is to eradicate the fallacies commonly held in regard to the human body.

PE 2. PHYSICAL TRAINING.

Freshman year, first term, 16 weeks, one hour per week.
Associate Professor Dennie.

All curricula.

A system of setting-up and developing exercises, the purpose of which is to build up and develop the muscular elements of the body and cohesion of bodily movement.

PE 3. PHYSICAL TRAINING.

Freshman year, second term, 16 weeks, two hours per week.
Associate Professor Dennie.

All curricula.

A continuation of PE 2, to include the use of dumb-bells and military setting-up exercises.

PE 4. PHYSICAL TRAINING.

Sophomore year, first and second terms, 32 weeks, two hours per week.

All curricula.

Exercises with dumb-bells, bar-bells, wands, chest-weights and the playing of indoor and outdoor games with the object of making the student more active mentally and physically.

PE 5. BOXING.

Open to all classes.

Instruction in elementary boxing and self-defence will include leads, blows, parries and defence. Shadow-boxing will be carried on until the students have mastered the art and then pairings will be made and men of similar weights will box with each other.

PE 6. SWIMMING.

Open to all classes.

Recognizing that ability to swim may often be of importance to the engineer, special attention is given to beginners, and all students are urged and encouraged to attain proficiency as early as possible in their school course.

PE 7. WRESTLING.

Open to all classes.

Purpose and general methods as in PE 5.

PHYSICS AND ELECTRICAL ENGINEERING

PROFESSOR WOODMAN, ASSISTANT PROFESSOR FRAME, ASSISTANT PROFESSOR RATLIFF.

EQUIPMENT

The Department of Physics and Electrical Engineering is located in Norwood Hall. The lecture room is in the southeast corner of the building on the first floor. On the same floor are found the office and recitation room used by the department. All of the laboratories are located in the basement of the building. The Physical Laboratory is a large, well-lighted room, and is well equipped with water and gas and suitable tables for carrying on nearly one hundred experiments especially chosen for engineering students. Another large room is well equipped with motors and generators of various types and ratings suitable for carrying on the work in electrical engineering. One room is being fitted up for work in electrical measurements and another is fitted with double doors and windows so that it can be used as a constant temperature room. There is also a shop for making and repairing apparatus.

The department is well equipped with apparatus for carrying on the work as it is outlined for engineering students. As the demand for courses in pure science increases, it is intended to increase the equipment so as to meet the needs and interests of these students.

COURSES

1000. GENERAL PHYSICS. *Lectures.*

Sophomore year, first term, four hours per week.
All curricula.
Text: Spinney, *A Textbook of Physics.*
Professor Woodman, Assistant Professor Ratliff.

This course includes the study of the mechanics of solids, liquids, and gases, and of heat, including an introduction to thermodynamics. Lectures, illustrated by experiments and recitations.

1001. GENERAL PHYSICS. *Laboratory.*

Sophomore year, first term, six hours per week.
All curricula (must be preceded or accompanied by 1000).
Professor Woodman, Assistant Professor Ratliff.

The laboratory is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of the relations between the quantities measured. Especial attention is given to the making of laboratory reports.

1002. GENERAL PHYSICS. *Lectures.*

Sophomore year, second term, four hours per week.
All curricula.
Text: Spinney, *A Textbook of Physics.*
Professor Woodman, Assistant Professor Ratliff.

The study of electricity and magnetism, sound, and light. Lectures, illustrated by experiments and recitations.

1003. GENERAL PHYSICS. *Laboratory.*

Sophomore year, second term, six hours per week.
All curricula (must be preceded or accompanied by 1002).
Professor Woodman, Assistant Professor Ratliff.

Deals with the subjects studied in course 1002 and the method is the same as that outlined in course 1001.

1010. ELECTRICITY AND MAGNETISM. *Lectures.*

Junior year, first term, three hours per week.
Curriculum IV (603, 1002, 1003).
Text: Starling, *Electricity and Magnetism.*
Professor Woodman.

Includes a mathematical discussion of fields of force, potential, capacity, resistance, and inductance. Emphasis is placed upon the solution of problems.

1011. ELECTRICITY AND MAGNETISM. *Laboratory.*

Junior year, first term, three hours per week.
Curriculum IV (must be preceded or accompanied by 1010).
Professor Woodman.

Includes the standard experiments in electrical measurements.

1012. LIGHT. *Lectures.*

Junior year, second term, three hours per week.
Curriculum IV (603, 1002, 1003).
Assistant Professor Ratliff.

An experimental and mathmematical discussion of reflection refraction, and polarization of light. There will be a discussion of

spectroscopy and an introduction to the electromagnetic theory of light.

1013. LIGHT. *Laboratory.*

Junior year, second term, six hours per week.
Curriculum IV (must be preceded or accompanied by 1012).
Assistant Professor Ratliff.

Based on the work covered in course 1012.

1014. HEAT. *Lectures.*

Senior year, first term, three hours per week.
Curriculum IV (603, 1000, 1001).
Text: Edser, *Heat for Advanced Students.*
Assistant Professor Ratliff.

An experimental and mathematical discussion of thermometry; laws of gases; expansion of solids, liquids and gases; calorimetry; change of state; vapors; mechanical equivalent of heat; and a brief discussion of thermodynamics.

1015. HEAT. *Laboratory.*

Senior year, first term, three hours per week.
Curriculum IV (must be preceded or accompanied by 1014).
Assistant Professor Ratliff.

Based on the work covered in course 1014.

1016. RADIOACTIVITY. *Lectures.*

Senior year, second term, three hours per week.
Curriculum IV (1000, 1002).
Professor Woodman.

An historical and descriptive study of the radioactive processes.

1017. RADIOACTIVITY. *Laboratory.*

Senior year, second term, three hours per week.
Curriculum IV (must be preceded or accompanied by 1016).
Professor Woodman.

Opportunity will be given in the laboratory to repeat some of the simpler experiments with radioactive substances.

1025. ALTERNATING CURRENT THEORY. *Lectures.*

Senior year, first term, three hours per week.
Curriculum VI (603, 1050, 1052).

Professor Woodman.

Includes the mathematical theory of simple harmonic motion, the analysis of wave forms by means of Fourier's Series, a discussion of the circuit equations for both direct and alternating currents, and the elementary theory of the transformer.

1026. ALTERNATING CURRENT THEORY. *Lectures.*

Senior year, second term, three hours per week.
Curriculum VI (1025).

Professor Woodman.

A continuation of course 1025.

1050. ELEMENTS OF ELECTRICAL ENGINEERING. *Lectures.*

Junior year, first term, three hours per week.
Curricula I, II, III, V, VI and VII (603, 1000, 1002).
Text: Dawes, *Electrical Engineering.*

Assistant Professor Frame.

The fundamental laws of electric and magnetic circuits; laws of direct current circuits; laws of alternating current circuits having harmonic electromotive forces; and the principles of electrical systems and machines.

1051. ELEMENTS OF ELECTRICAL ENGINEERING. *Laboratory.*

Junior year, first term, three hours per week.
Curricula I, II, III, V, VI, VII (must be preceded or accompanied by 1050).

Assistant Professor Frame.

The calibration of instruments; the measurement of the magnetic properties of iron and steel; the measurement of resistance, current, potential, capacity and inductance; and the characteristic curves of dynamos and transformers.

1052. ELEMENTS OF ELECTRICAL ENGINEERING. *Lectures.*

Junior year, second term, three hours per week.
Curricula I, II, III, V, VI, VII (1050, 1051).
Text: Dawes, *Electrical Engineering.*

Assistant Professor Frame.

A continuation of course 1050.

1053. ELEMENTS OF ELECTRICAL ENGINEERING. *Laboratory.*

Junior year, second term, three hours per week.

Curricula I, II, III, V, VI, VII (must be preceded or accompanied by 1052).

Assistant Professor Frame.

A continuation of course 1051.

1054. ELECTRIC TRANSMISSION AND DISTRIBUTION. *Lectures and Laboratory.*

Junior year, second term, three lecture hours and three laboratory hours per week.

Curriculum VI (1050, 1051).

Assistant Professor Frame.

A study of the construction and operation of long-distance transmission lines and overhead and underground distributing systems; plans and specifications of distribution and transmission systems; and the cost of production and distribution of power.

1055. ELECTRICAL MACHINERY. *Lectures.*

Senior year, first term, three hours per week.

Curriculum VI (1050, 1052).

Assistant Professor Frame.

A study of the various types of direct and alternating current machines with reference to their construction, operation, and uses in power work and industrial processes.

1056. ELECTRICAL MACHINERY. *Laboratory.*

Senior year, first term, three hours per week.

Curriculum VI (must be preceded or accompanied by 1055).

Assistant Professor Frame.

Laboratory practice in the construction, theory of operation, characteristics, efficiency, and heating of dynamos and transformers.

1057. ELECTRICAL MACHINERY. *Lectures.*

Senior year, second term, three hours per week.

Curriculum VI (1055).

Assistant Professor Frame.

A continuation of course 1055.

1058. ELECTRICAL MACHINERY. *Laboratory.*

Senior year, second term, three hours per week.

Curriculum VI (must be preceded or accompanied by 1057).

Assistant Professor Frame.

A continuation of course 1056.

1059. POWER STATIONS. *Lectures and Laboratory.*

Senior year, first term, three lecture hours and three laboratory hours per week.

Curriculum VI (1050, 1052).

Assistant Professor Frame.

A study of the electrical equipment and operation of central power plants and substations.

1060. ELECTRIC RAILWAYS. *Lectures and Laboratory.*

Senior year, second term, three lecture hours and three laboratory hours per week.

Curriculum VI (1052, 1053, 1054).

Assistant Professor Frame.

A study of the railway motor and auxiliaries; control of railway motors; train performance curves; signal service; track construction; electric locomotives; and commercial tests on standard machines.

1090. WORK IN PRACTICE.

Summer vacation following the Junior year.

Required in Curriculum VI.

To receive a degree in Electrical Engineering, the student (a) must have worked not less than twelve weeks in some electrical engineering plant or industry; or (b) if he is unable to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching at some electrical plant designated by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

1096. THESIS AND DESIGN. *Laboratory.*

Senior year, second term, twelve hours per week.

Curriculum VI (1052, 1053).

Professor Woodman, Assistant Professor Frame.

Each student is assigned a problem which will require original thought and investigation. He is expected to submit a complete report of his work, including the experimental processes involved, and the design of any special equipment or apparatus required in the solution of the problem. Such report must be filed with the head of the department not later than April 15th, and must conform to the specifications for theses described on page 34.

VOCATIONAL EDUCATION

PROFESSOR COOKE, ASSOCIATE PROFESSOR BILGER, ASSISTANT PROFESSOR BARDSLEY, MR. WOOLRYCH, MR. BREWER, MR. RANNEY, AND OTHER MEMBERS OF THE FACULTY OF THE SCHOOL OF MINES.

The Federal Board for Vocational Education sends ex-soldiers to the School of Mines for training. Some of these students are qualified to enter the regular courses given by the School; the remainder, because of their previous lack of training, are given special instruction to prepare them to fill remunerative positions.

This special instruction includes work in topographic engineering, highway engineering, mechanical engineering, and oil-field engineering. Though the greater part of the student's time is devoted to these special courses, a part of it is given up to mathematics and English, in order that he may become better grounded in these subjects.

TOPOGRAPHIC ENGINEERING.

It is expected that the students taking topographic engineering will, after a year's intensive training, be prepared for the duties of junior topographer and will be eligible for appointment under the United States Civil Service rules to positions in the United States Geological Survey. This course includes lecture and classroom exercises and field work. Standard equipment is available for each branch of the work, a part having been obtained from the Geological Survey. At the expiration of his training the student will have acquired the theory and a working knowledge of the various phases of the subject.

The principal subjects included in this course are triangulation, primary traverse, leveling, map projections, plane table work, contour construction, map drawing, and map reproduction. For a thorough understanding of these subjects, a more or less intimate knowledge of a variety of related subjects, such as geodesy, astronomy, terrestrial magnetism, and physiography is to be acquired.

1100. TOPOGRAPHIC ENGINEERING. *Lectures.*

January 3 to March 15, 10 weeks, three hours a week.
Course VIII.
Text: *Manuscript notes.*
Professor Cooke, Assistant Professor Bardsley.

The figure of the earth and its dimensions, results of meridian-arc measurements and pendulum observations, precise measurements and their reduction to the spheroid, meridian and latitude determinations by observations on the sun and stars, relation of sidereal, solar, and standard times, the earth's magnetism and its effect on the behavior of the compass, charting of the isogons and periodic changes in magnetic values, and a thorough expose of the fundamentals of topographic engineering.

1101. TOPOGRAPHIC OFFICE PRACTICE. *Laboratory.*

January 3 to March 15, 10 weeks, six hours a week.
Course VIII (1100).
Text: U. S. Geological Survey, *Topographic Instructions.*
Professor Cooke, Assistant Professor Bardsley.

The student will be thoroughly drilled in the making of tracings, the enlargement and reduction of maps, right-line drawing, free-hand lettering, conventional signs, map projections, plotting of geodetic co-ordinates; in short, every phase of the construction of a topographic map.

1102. TOPOGRAPHIC FIELD PRACTICE. *Laboratory.*

March 16 to April 29, 6 weeks, thirty-five hours a week.
Course VIII (1100, 1101).
Professor Cooke, Assistant Professor Bardsley, Mr. Brewer, Mr. Ranney.

The student will be drilled in triangulation, primary traverse, leveling, plane table work, astronomic observations, adjustment and care of instruments, and general field methods.

1103. GEODETIC COMPUTATIONS. *Lectures.*

January 3 to March 15, 10 weeks, one hour a week.
Course VII (Trigonometry).
Text: *Manuscript Notes.*
Professor Cooke, Assistant Professor Bardsley.

Computations of the results of triangulation, including reduction of base-line measurements, tabulation of angles, reduction to center, correction for swing, computations of spherical excess, computation of the inverse solution, least-square adjustment, computation of geodetic co-ordinates, and computation of "three-point" problem. Computation of the results of primary traverse, including computation of deflection angles, computation of latitude and longitude, computation of diagonals, and computation of astronomic observations.

1104. PHYSIOGRAPHY. *Lectures.*

January 3 to March 15, 10 weeks, two hours a week.
Course VIII.
Text: Hopkins, *Elements of Physical Geography.*
Professor Cooke, Assistant Professor Bardsley.

A study of the features of the earth and of the physiographic processes which have wrought the changes in the surface forms. This subject is designed as an aid to the proper delineation of these features on topographic maps.

1105. PHYSIOGRAPHY. *Laboratory.*

January 3 to March 15, 10 weeks, three hours a week.
Course VIII (1104).
Text: U. S. Geological Survey, *Quadrangles.*
Professor Cooke, Assistant Professor Bardsley.

This is a course in the interpretation of maps and is given in conjunction with course 1104.

1106. PRACTICAL MATHEMATICS. *Lectures.*

January 3 to March 15, 10 weeks, five hours a week.
Course VIII.
Texts: Marsh, *Industrial Mathematics,*
Wells and Hart, *Academic Arithmetic.*
Mr. Fischlowitz.

This course is designed for those whose mathematical training is scant as well as for those who have had more training, and embraces the most elementary parts of the subject. It is designed to prepare the student for the employment of logical reasoning in his mathematical computations and to give him the ground-work in mathematics. The course is divided into three sections in order to meet the individual requirements of the student.

Subjects: The fundamental operations, fractions, proportion, weights and measures, mensuration, measuring instruments, weight, pulleys, belts, horse-power, solution of an equation, logarithms, solution of a triangle, use of tables, slide rule, etc.

1107. PRACTICAL ALGEBRA. *Lectures.*

January 3, to March 15, 10 weeks, five hours a week.
Course VIII (1106, or equivalent).
Text: Wells and Hart, *New High School Algebra.*
Mr. Fischlowitz.

This course aims to make the transition from arithmetic to algebra as easy and natural as possible, and at the same time to arouse and sustain the student's interest in the new field of work and

eventually to make the student proficient in the fundamental algebraic processes and in their application to the numerous computations in the branches of engineering he may elect to pursue later in his course. The course will start from the elements of algebraic reasoning and carry the student through all the fundamental parts of the subject to quadratics.

1108. ADVANCED ALGEBRA. *Lectures.*

January 3 to March 15, 10 weeks, five hours a week.
Course VIII (1107).
Text: Wells and Hart, *New High School Algebra.*

Mr. Colbert.

This course is a continuation of course 1107 and deals with more advanced portions of the text and gives practical applications of the subject.

1109. PRACTICAL TRIGONOMETRY. *Lectures.*

January 3 to March 15, 10 weeks, five hours a week.
Course VIII (1107, or equivalent).
Texts: Marsh, *Technical Trigonometry,*
Taylor and Puryear, *Trigonometry.*

Mr. Colbert.

The aim of this course is to give the student an intelligent and usable knowledge of the trigonometry underlying the technical and professional studies. The course is designed for vocational students who have not had the advantage of high school training in mathematics. It differs from the regular collegiate course in the extent of time generally alloted to complete the course.

Subjects: Logarithms, use of tables, the right triangle, relation of functions, use of the slide-rule, geometrical applications, latitudes and departures, simple triangulation, radian measure, applications to surveying, etc.

1110. ADVANCED TRIGONOMETRY. *Lectures.*

January 3 to March 15, 10 weeks, five hours a week.
Course VIII (1109).
Texts: Marsh, *Technical Trigonometry,*
Taylor and Puryear, *Trigonometry.*

Mr. Guy.

A continuation of course 1109.

1111. ENGLISH. *Lectures.*

January 3 to March 15, 10 weeks, three hours a week.
Course VIII.
Text: Buhlig, *Business English.*

Mr. Woolrych.

Designed to give the student a basis for the knowledge and use of correct English.

1112. CONVERSATIONAL SPANISH. *Lectures.*

January 3 to March 15, 10 weeks, two hours a week.
Curriculum VIII.
Text: Cortina, *Spanish Methods.*

Mr. Cambiaire.

Designed to give the student a sufficient knowledge of the language to enable him to carry on an ordinary conversation in Spanish.

HIGHWAY ENGINEERING.

The course is designed to meet the needs of men who have not had the advantage of secondary education and will be strictly practical in both field and office practice. There is a constant demand for highway engineers; a good many states have liberal bond issues for road construction, and at present there is not a better or more remunerative field for the engineer than work of this type. This course is designed to cover from one year to eighteen months, according to the previous training of the student. In addition to the office and field work in highway engineering, the student will be drilled in English, mathematics, and other subjects, a knowledge of which will tend to broaden his views as an engineer.

1113. HIGHWAY ENGINEERING. *Lectures.*

January 3 to March 15, 10 weeks, three hours a week.
Course VIII.
Text: Blanchard and Drowne, *Highway Engineering.*

Associate Professor Bilger.

Historical review, preliminary investigations, surveying and mapping, design, drainage, foundations, earth and sand-clay roads, gravel roads, broken stone roads, bituminous roads, wood-block pavements, street cleaning and snow removal, car tracks, pipe systems, comparison of roads and pavements, sidewalks, curbs and gutters, bridges, culverts and guard rails, economics, administration and legislation.

1114. HIGHWAY ENGINEERING. *Laboratory.*

January 3 to March 15, 10 weeks, nine hours a week.
Course VIII.
Text: *Manuscript Notes.*

Associate Professor Bilger.

Plotting of survey, the profile, relation of roads to section lines, horizontal curves, vertical curves, grade, design of bridges and culverts, maximum loading, adaptable surfaces, cost, proximity of materials, and tests of road materials.

1115. HIGHWAY FIELD PRACTICE. *Laboratory.*

March 16 to April 29, 6 weeks, twenty-one hours a week.
Course VIII (1113, 1114).
Text: Allen, *Field Tables.*

Associate Professor Bilger.

The work will be done in connection with the actual mapping of highways in the vicinity of Rolla and probably in cooperation with State highway engineers. It will mainly consist of surveys for roads, city streets, grading, and repairing. Other features will be: The transit line. levels, final survey, staking grades, the plan, profile, cross-sections, the traverse, and topographic maps.

1116. HIGHWAY FIELD AND OFFICE COMPUTATIONS. *Laboratory.*

March 16 to April 29, 6 weeks, fourteen hours a week.
Course VIII (1115).

Associate Professor Bilger.

A compilation of results from course 1115.

OIL-FIELD ENGINEERING.

The oil industry has become one of the most important cogs in the machinery of progress today, and the demand for oil products far exceeds the supply. From time to time new fields are discovered and the search for new territory is constantly going on. Naturally the growth of the industry and the demand for trained men go hand in hand, and this special course is designed to prepare men for positions as oil-field engineers in places where there is a demand for their services and the emoluments are attractive.

1117. OIL ENGINEERING DRAFTING. *Laboratory.*

March 16 to April 29, 6 weeks, twelve hours a week.
Course VIII.
Text: *Leesee Maps.*

Mr. Woolrych.

Compiling county maps showing legal surveys, ownership and well locations; special oil pool maps showing operating companies, oil wells, dry holes, pipe lines, etc.; making scout territory

maps using colors, likewise lessee's territory maps; drawing lease charts from the oil lease; figuring acreage; checking maps from scout reports.

1118. GRAPHIC PRESENTATION OF OIL STATISTICS. *Laboratory.*

January 3 to April 29, 16 weeks, six hours a week.
Course VIII (1117).
Text: *Oil Charts.*

Mr. Woolrych.

This course consists of general principles pertaining to the use of charts: organization charts, cost analysis charts, rectilinear column, bar and circle charts, gathering of data for permanent records of wells, leases and oil pools; sources of information.

1119. VALUATION OF OIL PROPERTIES. *Laboratory.*

January 3 to April 29, 16 weeks, six hours a week.
Course VIII.
Text: *Manuscript Notes and Maps.*

Mr. Woolrych.

Expected performance estimated from past performance of wells, leases and fields; items of cost entering into the development of oil properties; plotting curves to judge ultimate future production of wells, leases or fields, etc.

1120. ELEMENTARY ARCHITECTURAL DRAWING. *Laboratory.*

January 3 to April 29, 16 weeks, six hours a week.
Course VIII.
Texts: *Manuscript Notes.*
French, *Engineering Drawing.*

Assistant Professor Mann.

This course consists in the drawing and tracing of foundation and superstructure plans for houses, simple steel frame buildings, and various public buildings. Details of roof trusses and columns are drawn and traced. The elements of perspective as applied to architectural drawing are taught, and the student is made familiar with the various drawing conventions and handbooks used in this class of work.

DURATION OF VOCATIONAL EDUCATION.

The foregoing statement of courses summarizes the work of the Department of Vocational Education as offered during the winter semester of 1921. The work of this Department will be continued beyond the present academic year, and additional courses will be arranged.

GENERAL INFORMATION

Student Health.—The student health is carefully looked after. Fifteen lectures are given on hygiene to all first-year students during the first term. A thorough physical examination is made of every student entering school and his physical exercises are directed by the Physical Director and Medical Examiner.

Jackling Loan Fund.—Loans may be made to students of the School of Mines from the Jackling Loan Fund. The purpose of the Jackling Loan Fund is to help worthy students who require financial assistance and who are unable to borrow money from other sources. Primarily, the fund was established to help students who are well along in their work, such as Seniors or Juniors.

The following conditions must be fulfilled:

1. The student, in order that he may become a borrower, shall have been in attendance at the School for at least one year, and if the condition of the fund warrants it, the application from such men may receive the consideration of the Executive Committee.

2. Written requests for loans must be filed with the Director and are considered by the Executive Committee of the Board of Curators.

3. No loan of more than $100 may be made to any one student during the calendar year, and not more than $25 is paid on such loans at one time.

4. The student shall give his note for the amount of the loan. Said note shall bear interest at the rate of five per cent. per annum from the date of the note to one year after the student's graduation or his leaving the School of Mines, and for one year following at the rate of eight per cent. per annum. The note shall then become due.

5. The parent or guardian must sign the application for the loan and the note with the student.

The American Association of Engineers, Missouri School of Mines Chapter.—The American Association of Engineers is a national organization, comprising all branches of the engineering profession. Its objects are to advance the standing of the profession and to promote the welfare and success of its members, particularly in non-technical matters.

The Missouri School of Mines Chapter was chartered in April, 1920, and has already come to be a recognized force in the school. All students are eligible to membership, and over half are members.

The chapter operated a Service Bureau at the opening of school, whereby, with the co-operation of the Rolla Chamber of

Commerce, it was able to locate rooms for a great many of the new students. This service was entirely free and will be repeated each year.

The chapter stands for any movement which is for the good of the school, the city of Rolla, or both, its prime object being service—to members first, but also to the public at large. As it specializes on non-technical matters, it does not in any way conflict or compete with technical organizations. Its field, therefore, is practically unlimited.

The chapter officers for the year 1920-21 are:

H. H. Armsby . . . . *President*
J. P. Colbert, '21. *1st Vice-President*
C. E. Bardsley . . . . *2nd Vice-President*
E. M. Guy, '21 . . . . *Secretary-Treasurer*

The Missouri Mining and Metallurgical Association.—The objects of the Mining and Metallurgical Association are to advance the knowledge of mining among its members, to promote good fellowship among the students and alumni of the School of Mines and others interested in mining, and to bring the School into closer relation with the mining profession at large. Students in the School of Mines who have passed in sixty-three credit hours are eligible to membership, as are also alumni.

This association is affiliated with the American Institute of Mining and Metallurgical Engineers, and any member of it may become a junior member of the Institute. Such membership carries with it most of the privileges of regular membership at about one-half of the cost and with no initiation fee.

Officers of the association for the year 1920-21 are:

A. F. Delaloye, '21. . . . . *President*
A. L. Ackers, '22. *Secretary-Treasurer*

Metallurgical and Chemical Society.—The society meets fortnightly for the consideration and discussion of addresses, lectures, and informal talks on metallurgical and chemical topics—theoretical, practical, and industrial—delivered by students, faculty, and visiting professional men.

Students of metallurgy or chemistry with at least forty-three hours' credit are eligible as active members; other students having forty-three hours' credit or more may become associates.

The officers for 1920-21 are:

H. Taylor, '21 . . . . *President*
P. H. Karges, '22 . . . . *Vice-President*
O. Ehler, '22 . . . . *Secretary-Treasurer.*

Student Council.—The Student Council has for its object the promotion of various student enterprises and activities, and the maintenance of a spirit of mutual confidence between the student body and the faculty. The Council is composed of three Seniors and two Juniors, selected by the entire student body.

The members of the Council for 1920-21 are:

Thomas Glover Weir, '22, *President.*
Lewis Ely Davidson, '21.
August Francis Delaloye, '21.
Robert Knox Stroup, '21.
Warren Roy Gettler, '22.

Athletic Association.—The object of the Association is to unite the various efforts of the School in athletic sports. All students pay an athletic fee of five dollars a semester, which entitles them to membership in the Athletic Association, to admission to all athletic contests held under the auspices of the Athletic Association, and to golf club and gymnasium privileges. Members of the faculty may become members of the Association by the payment of the stipulated fee. The Association elects its own officers and has general charge of all school athletics. The financial affairs of the Association are handled by a Board of Control. (See under Physical Training, page 127.)

The officers of the Association for 1920-21 are:

H. L. Bailey, '21	*President*
M. I. Signer, '22	*Vice-President*
Edw. Kahlbaum	*Secretary-Treasurer*
J. E. Jewell, '22	*Business Manager*
E. M. Guy, '21	*Cheer Leader*

The Rollamo.—The *Rollamo*, first published in 1907 by the fraternities, is now edited by a staff chosen from the entire student body. The publication is the official yearbook of the school, and chronicles in permanent form the activities of the school year.

The Board for 1920-21 consists of the following:

J. E. Jones, '21	*Editor-in-Chief*
J. F. Hosterman, '22	*Associate Editor*
Joe M. Wilson, '21	*Art Editor*
K. H. deCousser, '22	*Athletic Editor*
W. H. Dunlop, '22	*Assistant Editor*
R. Erickson, '22	*Secretary*
H. Taylor, '21	*Business Manager*
H. E. Diers, '22	*Assistant Business Manager*
W. E. Case, '22	*Photographer*

The Missouri Miner.—*The Missouri Miner* is a weekly publication and was established in 1914-1915. It records the news of each week of interest to the student body and to the Alumni. It has been adopted as the official organ of the Alumni Association.

The staff for 1920-21 is as follows:

H. O. Norville, '21 . . . . *Editor-in-Chief*
H. L. Leonard, '22 . . . . *Associate Editor*
A. B. Wilkerson, '23 . . . . *Assistant Editor*
E. S. Wheeler, '22 . . . . *Sports Editor*
Joe M. Wilson, '21 . . . . *Cartoonist*
K. W. Booker, '21 . . . . *General Manager*
W. F. Netzeband, '21 . . . . *Business Manager*
W. K. Teller, '22 . . . . *Assistant Business Manager*
Herron Hollow, '22 . . . . *Advertising Manager*
S. M. Burke, '23 . . . . *Circulation Manager*
G. A. Zeller, '23 . . . . *Assistant Circulation Manager*

Fraternities.—There are five Greek-letter college fraternities, each maintaining a chapter house: Gamma XI of Zigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha, and Alpha Delta Zeta of Lambda Chi Alpha.

Scholarship Fraternities.—The engineering scholarship fraternity, Tau Beta Pi, established its Missouri Beta chapter in the school in 1908; and in 1916 the professional engineering fraternity, Theta Tau, installed its Iota chapter. On January 29, 1920, the scholarship fraternity, Phi Kappa Phi, installed its Missouri School of Mines chapter. On December 20, 1920, the geological mining and metallurgical fraternity, Sigma Delta Epsilon, installed its Eta Chapter.

Clubs.—The following clubs, Grubstakers, Prospectors, Bonanza, and Independents, are organized for the benefit of the members. Some of these clubs maintain boarding and rooming houses.

UNITED STATES BUREAU OF MINES
MISSISSIPPI VALLEY EXPERIMENT STATION

As the result of co-operative agreement between the School and the United States Bureau of Mines, the Mississippi Valley Experiment Station of the Bureau of Mines has been established with business office in St. Louis and the laboratories at Rolla. The activities of this station will cover the lead and zinc fields of the Mississippi Valley and will deal with such problems as arise in the lead and zinc industry of a mining, ore dressing, or metallurgical nature, and are of a general character, the solution of which would tend to increase the efficiency of the industry and the economic development and conservation of the lead and zinc resources in

the prevention of waste of such resources in the territory served by the station.

One of the first problems to be undertaken by the station was a study of methods for an economic separation of the lead-zinc-fluorspar ore encountered in the lower workings of the fluorspar mines of Southern Illinois and Northern Kentucky. A study of the mechanical methods of hauling and underground handling of dirt was also undertaken. This involves a study of the different mechanical methods in use in the district for this purpose, this data to be correlated with that obtained in other districts served by the bureau. A third problem undertaken was the study of the improvement of zinc recovery in the Wisconsin field. The possibilities of flotation on these ores will be thoroughly investigated. A study is being made of the efficiency of drill steels under various working conditions. Preparations are going forward for the beginning of research covering the electrothermic metallurgy of zinc. Other problems to be taken up by the station in the future are a study of the milling methods in the Joplin District and research covering the development of an economic flotation oil.

The staff of the station is as follows:

J. J. Rutledge	*Superintendent*
John Gross	*Metallurgist*
Will. H. Coghill	*Metallurgist*
Mathew van Siclen	*Mining Engineer*
C. O. Anderson	*Assistant Metallurgist*
J. Walter Scott	*Assistant Chemist*
Noel Hubbard	*Principal Clerk*
Albert J. Johns	*Clerk*

THE STATE MINING EXPERIMENT STATION

Martin H. Thornberry, B. S., Met. E.... *Research Metallurgist*

Consultants:

William DeGarmo Turner, Ph. D.	*Professor of Chemistry*
Carroll Ralph Forbes, E. M.	*Professor of Mining*
Charles Laurence Dake, Ph. D	*Professor of Geology*
Charles Yancey Clayton, Met. E.	*Professor of Metallurgy*

The Mining Experiment Station was established by the Board of Curators, June 1, 1909.

It is the object of the station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing

waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters; to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and metallurgical engineering to the mineral industry of the State of Missouri.

The following bulletins are of recent issue:

Bibliography of Roasting, Leaching, Smelting and Electrometallurgy of Zinc, by H. L. Wheeler.

The Effect of Addition Agents in Flotation, Part II, by M. H. Thornberry and H. T. Mann.

Road Problems in the Ozarks, by E. G. Harris. Second edition, rewritten and enlarged.

The Carbonization of Missouri Cannel Coals, by H. L. Dunlap.

Any resident of the State may on request obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Correspondence regarding these bulletins or the work of the Station may be addressed to the Director, Mining Experiment Station, Rolla, Missouri.

During the past year over 1,200 samples of ores, clays, coals, water, asphaltum, limestones, etc., were identified, tested or analyzed in some manner by the staff of the Experiment Station for citizens of Missouri.

MISSOURI BUREAU OF GEOLOGY AND MINES

(MISSOURI GEOLOGICAL SURVEY)

The Missouri Bureau of Geology and Mines—or The Missouri Geological Survey, as it is more commonly known—has its headquarters at Rolla, and occupies the Rolla Building on the School campus.

BOARD OF MANAGERS

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STATE GEOLOGIST

H. A. BUEHLER.

EQUIPMENT AND INVESTIGATIONS

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects, and a museum of seven thousand specimens of clay, coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri.

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of geology to the ore deposits is also worked out and detailed reports published concerning such investigations.

The Geological Survey has the following reports available for distribution at the present time:

Preliminary Report	Vol. XIII.
Geology of Miller County	Vol. I., 2d series.
Quarrying Industry of Missouri	Vol. II., 2d series.
Geology of Moniteau County	Vol. III., 2d series.
Geology of the Granby Area	Vol. IV., 2d series.

DEGREES

CONFERRED IN 1920

Bachelor of Science in Mine Engineering

Kenneth Aid
Daniel Christopher Beyer
Matthew Patrick Brazil, Jr.
Juan Rafael Casanovas
Lawrence Owen Casselman
Lorain Harry Cunningham
Gerard Ernest Ebmeyer
Artileus Vosteen Eulich
Osher Goldsmith
Wesley George Hippard
Harland Hobart Hoppock
Clifford Peter Howard
John Leslie Howendobler
Thomas Witt Leach
Maurice Cecil Lucky
Frank Morris McMillen
Robert L. Marston
Frederick Vail Moore
Earle Nelson Murphy
William Latchaw Niece
William John Nolte
Arthur Henry Petsch
Gerald Franklin Rackett
Rudolph Charles Schappler, A. B., A. M.
Oscar Eli Stoner
Frederick William Uthoff
William Walbridge Weigel
Kenneth Maurice Wright

Bachelor of Science in Metallurgy

Carl Bernard Hummel
George Alfred Kroenlein
Allen Dewey Potts
Edwin Allsop Slover
Ronald Owen Swayze
Mark Loren Terry
Rafael Esteban Velasco

Bachelor of Science in Civil Engineering

Evan Earl Ashlock
Clarence Edward Bardsley
Charles Russell Barnard
George Burnet
Karl William Heimberger
Louis Merryl McCarty
Joseph Novak, Jr.
Edwin Kaine Schuman, LL. B.
Ronald Blair Wills
Harry Wesley Zieseniss

Bachelor of Science in General Science

Peter Harold Pietsch

Bachelor of Science in Mechanical Engineering

William Miskey Taggart, Jr.

Bachelor of Science in Chemical Engineering

David Anderson Bash
Eugene Dreidel
William James Finlay
Carl Andrew Gettler
Leon Harrison Goldman
Arthur Mark Howald
Karl Kenneth Kershner
Frederick Arthur Krause
Edgar Arthur Williams

Master of Science in Metallurgy

Thomas Patrick Walsh, B. S. '17
Hanley Weiser, B. S. '18

Master of Science in Chemical Engineering

Karl Kenneth Kershner
Arthur Mark Howald

Engineer of Mines

Joseph C. Barton, B. S. '17
Leonidas James Boucher, B. S. '14
Phillips Brooks Dolman, B. S. '17

Metallurgical Engineer

John Owen Ambler, B. S. '06
Frank Stillman Elfred, Jr., B. S. '17
Ray Gould Knickerbocker, B. S. '13
Earl Joesting McNely, B. S. '16
Martin Harmon Thornberry, B. S. '12

Civil Engineer

Enoch Ray Needles, B. S. '14

STUDENTS

GRADUATE STUDENTS

Badollet, Marion Smith, B. S. '19. . . . *Vincennes, Ill.*
Bowles, John Hyer, B. S. '07 . . . . *Lake Springs, Mo.*
Clarke, Georgena Josephine, B. S. '18, University of Missouri. . . . . *Rolla, Mo.*
Davidson, Lewis Ely, B. S. '19 . . . . . . *Savannah, Mo.*
Fischlowitz, Victor Kopple, B. S. '19 . . *St. Louis, Mo.*
Frame, Floyd Hill, A. B. '12, Clark College . . . . *Rolla, Mo.*
Lloyd, Samuel Horace, A. B., DePauw University . . . . *Vincennes, Ind.*
Millar, Charles James, B. S. '20 . . . . . *Webb City, Mo.*
Nudelman, Barney, B. L. '19 . . . . *St. Louis, Mo.*
Shaw, Frederick William, M. D., '06 University of Kansas . . . . *Rolla, Mo.*
Weigel, William Walbridge, B. S. '19 . . *Fredericktown, Mo.*

CLASS OF 1921

Mine Engineering

Bailey, Harold Leland . . . . *Virginia, Ill.*
Booker, Karl William . . . . *Kansas City, Mo.*
Burford, Carroll Preston . . . . *Beaumont, Tex.*
Chang, Kyang Yu . . . . *Honan, China.*
Collins, Lawrence . . . . *Quincy, Ill.*
Delaloye, August Francis . . . . *Rolla, Mo.*
Forman, Percy . . . . *Rolla, Mo.*
Guy, Earl McKinley . . . . *Davenport, Ia.*
Hollingshead, Homer Archer . . . . *St. Joseph, Mo.*
Hughes, Harry Herbert, Jr. . . . . *Santa Monica, Cal.*
Hurd, Harold Waller . . . . *Paris, Mo.*
Hurst, Henry William . . . . *Kansas City, Mo.*
Keeler, William Weaver . . . . *Tulsa, Okla.*
Kerr, Homer Chalmers . . . . *Rolla, Mo.*
Lepper, Lewis . . . . *Marlboro, Mass.*
Lumpkin, Lloyd Earl . . . . *Jefferson City, Mo.*
Miller, Edwin Lawrence, Jr. . . . . *Kansas City, Mo.*
Mize, Charles Roderick . . . . *Independence, Mo.*
Needham, Albert Booth . . . . *Collinsville, Ill.*
Netzeband, William Ferdinand . . . . . . *St. Louis, Mo.*

Norville, Howard Oliver . . . . *Rolla, Mo.*
Patterson, Harold . . . . *Warrensburg, Mo.*
Quilliam, William Reed . . . . *Fowlerton, Tex.*
Salmon, Julius Clarence, Jr . . . . *Rayville, La.*
Stewart, William Lincoln, Jr . . . . *Pittsburgh, Pa.*
Stroup, Richard John . . . . *Quincy, Ill.*
Stroup, Robert Knox . . . . *Quincy, Ill.*
White, Fred Pope . . . . *E. St. Louis, Ill.*
Wilson, James Mortimer . . . . *Hannibal, Mo.*
Wilson, Joseph Martland . . . . *Rock Rapids, Ia.*

Metallurgy

Cairns, Arthur Lee . . . . *Cape Girardeau, Mo.*
Crow, Wayman . . . . *St. Louis, Mo.*
Huffman, Daniel Elijah, Jr. . . . . *St. Louis, Mo.*
Miller, John Gaines . . . . *Marshall, Mo.*
Rohloff, Joseph Herman . . . . *St. Joseph, Mo.*
Schumacher, Leon Burr. . . . . *St. Louis, Mo.*
Shih, Hsin Pu . . . . *Honan, China.*
Wheeler, Ernest Sterling . . . . *Madrid, Ia.*

Civil Engineering

Bohn, Edwin Joseph . . . . *St. Louis, Mo.*
Colbert, Jules Philip . . . . *Maryville, Mo.*
Denison, William Ray . . . . *Rolla, Mo.*
Williams, Anvil Clark . . . . *Sullivan, Mo.*

Electrical Engineering

Keeter, Vern Ivan . . . . *Maysville, Mo.*
Wallace, Milton Wardwell . . . . *East Orange, N. J.*

Chemical Engineering

Ehler, Otto . . . . *Washington, Mo.*
Laun, Albert Charles . . . . *St. James, Mo.*
Millar, Charles James . . . . *Webb City, Mo.*
Taylor, Huston . . . . *Rolla, Mo.*

General Science

Bloom, George Barnett . . . . *Maysville, Mo.*
Whitworth, Virgil Lee . . . . *Nevada, Mo.*

CLASS OF 1922

Mine Engineering

Ackers, Albert Louis . . . . *Staunton, Ill.*
Baxter, William Hampton . . . . *Washington, D. C.*
Bolt, William Weeks . . . . *Springfield, Ill.*
Brandenburger, Oscar Louis . . . . *Belleville, Ill.*
Bulger, John Leo . . . . *Gouverneur, N. Y.*
Cameron, Campbell Robinson . . . . *McAlester, Okla.*
Childress, Harold Lyle . . . . *Galena, Kan.*
Christner, Glen Joyce . . . . *Horton, Ran.*
deCardenas, Emilio . . . . *La Paz, Bolivia.*
deCousser, Kurt Herman . . . . *Rolla, Mo.*
Crawford, Howard Stanley . . . . *Rivera, Cal.*
Denison, Alvis Frederick . . . . *Cushman, Ark.*
Dunlop, William Harry . . . . *Beardstown, Ill.*
Edwards, James Carter . . . . *Jefferson City, Mo.*
Fiedler, John Ray . . . . *Shelbyville, Ind.*
Gollub, Meyer . . . . *St. Louis, Mo.*
Hagood, Lindell . . . . *Marshall, Mo.*
Hahn, Abner Decker . . . . *Muscatine, Ia.*
Ham, Neal Manget . . . . *Montgomery, Ala.*
Hodges, Isaac Franklin . . . . *Granby, Mo.*
Hoke, William Franklin . . . . *Lee's Summit, Mo.*
Hosterman, John Francis . . . . *Kansas City, Mo.*
Huckins, Julian Greenway . . . . *Kirkwood, Mo.*
Hunt, Russell Wayne . . . . *Independence, Mo.*
Jewell, James Edwin, Jr . . . . *Kansas City, Mo.*
Jones, James Ewart . . . . *Pasadena, Cal.*
Keeler, Edgar Allen . . . . *Tulsa, Okla.*
Kohlbry, Francois Paul . . . . *St. Louis, Mo.*
Leonard, Homer Lakirby . . . . *Rolla, Mo.*
Loesche, Harry Charles . . . . *St. Louis, Mo.*
Ma, Heng Yung . . . . *Honan, China.*
Metzger, William Herman . . . . *St. Louis, Mo.*
Owens, Irwin King . . . . *St. Louis, Mo.*
Packman, Nathan . . . . *St. Louis, Mo.*
Reid, Sidney Kincaid . . . . *McAlester, Okla.*
Richards, Robert Earl . . . . *Hutchinson, Kan.*
Richert, George Leo . . . . *Denver, Col.*
Rixleben, Bruno . . . . *Jonesboro, Ill.*
Rucker, Ambrose Chockley . . . . *Keytesville, Mo.*
Sample, Truman George . . . . *Fredericktown, Mo.*
Signer, Merton Ira . . . . *Tonica, Ill.*
Smith, Charles Landon . . . . *Rolla, Mo.*
Truebger, Frederick Francis . . . . *Petersburgh, Ind.*

Valentine, Herman Frederick........*Marshall, Mo.*
Weir, Thomas Glover...............*Webster Groves, Mo.*
Windsor, Paul Donovan.............*Belleville, Ill.*
Wolverton, Thatcher Siprell..........*Green River, Utah.*
Wyman, Glen Sherman.............*Kansas City, Mo.*

Metallurgy

Coffey, Glen Verlan.................*Wabash, Ind.*
Devereux, Andrew..................*Pachuca, Hgo. Mex.*
Diers, George Peter.................*East Orange, N. J.*
Diers, Henry Ernest.................*East Orange, N. J.*
Gettler, Warren Roy................*Hannibal, Mo.*
Karges, Paul Henry.................*Kansas City, Mo.*
Kimmel, Victor Edward.............*Rochester, N. Y.*
Updike, Donald Foster..............*Plainfield, N. J.*

Civil Engineering

Erickson, Roy Oscar................*Madrid, Ia.*
Kaullen, Fred Adam................*Jefferson City, Mo.*
Kenyon, Ronald John...............*Rolla, Mo.*
Machin, Edwin Gilbert.............*Bluffton, Mo.*
Manning, Roger Ignatius...........*Accokeek, Md.*
Rountree, Newton Marshall.........*Springfield, Mo.*
Smith, Ralph Day...................*Hutchinson, Kan.*
Teis, Kenneth Robert...............*Parkville, Mo.*
Watts, Aubrey Byron...............*Fredericktown, Mo.*

Mechanical Engineering

Hayes, Stanley Merton..............*Wellsville, Mo.*

Electrical Engineering

Case, Walker Ernest................*Rolla, Mo.*
Halasey, Francis Richard...........*Maryville, Mo.*
Homer, St. Clair....................*Caddo, Okla.*

Chemical Engineering

Frey, Muir Luken..................*Bunker Hill, Ill.*
Knight, Ralph Henry...............*St. Louis, Mo.*
Lenox, Jennie Lynn...............*Rolla, Mo.*
Rembert, Ernest Wayne...........*Jefferson City, Mo.*

General Science

Torrence, Edward, Jr................*St. Louis, Mo.*

CLASS OF 1923

Mine Engineering

BeDell, Milo Nanson . . . . *St. Louis, Mo.*
Burch, Ivan C. . . . . *Georgetown, Ill.*
Burke, Stephen Michael . . . . *St. Louis, Mo.*
Buser, Henry Clarence . . . . *Webster Groves, Mo.*
Canales, Francisco Alejandro . . . . *Ayacuhho, Peru.*
Cathcart, Everett Hunter . . . . *Kansas City, Mo.*
Chomeau, Henri . . . . *Clayton, Mo.*
Dooley, Glenn Angus . . . . *Joplin, Mo.*
Fischer, Paul Edgar . . . . *Webster Groves, Mo.*
Fleck, Howard . . . . *El Paso, Tex.*
Gibson, Dod Graham. . . . . *Webster Groves, Mo.*
Gordon, John Pemberton, Jr . . . . *Jefferson City, Mo.*
Grady, Robert F., Jr . . . . *St. Louis, Mo.*
Haberthier, Joseph John . . . . *Wichita, Kan.*
Healy, Michael Vincent. . . . . *Macon, Mo.*
Hegwer, Paul Jent . . . . *Sarcoxie, Mo.*
Henderson, Frank Irving . . . . *St. Louis, Mo.*
Hendry, David John . . . . *St. Louis, Mo.*
Hoffman, Ralph Andrew . . . . *Rolla, Mo.*
Hollow, Francis Herron . . . . *Cuba, Mo.*
Hoover, B. F. . . . . *Trenton, Mo.*
Hunter, Francis Kinloch Middleton . . . *Rolla, Mo.*
Jewell, Armin Brene . . . . *Tulsa, Okla.*
Kaley, Charles Bayard . . . . *Gouverneur, N. Y.*
Keyes, Irvin Wilson . . . . *Richmond, Mo.*
Lay, Willard Claxton . . . . *St. Clair, Mo*
Layton, Ben McColloch . . . . *Ferguson, Mo.*
Martyn, Phillip Francis . . . . *Cuba, Mo.*
Matlock, Fred Palmore . . . . *Overland Park, Mo.*
Meeks, Felix Zollicoffer . . . . *Marshall, Mo.*
Millikan, Carl E . . . . *Buffalo, N. Y.*
Moore, Hamilton . . . . *St. Louis, Mo.*
Mosena, Charles Clifford. . . . . *Falls City, Neb.*
Murphy, James Kenneth . . . . *Vinita, Okla.*
Murphy, Raymond Edward . . . . *Galena, Ill.*
McBride, Hollis Eugene . . . . *Cape Girardeau, Mo.*
McClellan, Maurice Hunter . . . . *Eminence, Mo.*
Nunnally, Hilliard Nolan . . . . *Texarkana, Tex.*
Orr, Raymond Fitzgerald . . . . *Webb City, Mo.*
Parkhurst, Arlis Beckham. . . . . *Tulsa, Okla.*
Pence, Harry Simanton . . . . *Falls City, Neb.*
Pesout, Edward . . . . *St. Louis, Mo.*

Runge, Charles Adelbert . . . . *Kirkwood, Mo.*
Ruoff, Carl Matthews . . . . *Hannibal, Mo.*
Sapper, Ferdinand Eugene . . . . *Galveston, Tex.*
Schmidt, Karl August . . . . *Springfield, Mo.*
Schwarz, Herbert Grunbach . . . . *Syracuse, N. Y.*
Sotier, Alfred Leon . . . . *St. Louis, Mo.*
Storrs, Stuart Esselman . . . . *Hannibal, Mo.*
Teller, Kedzie . . . . *Riverside, Ill.*
Teter, William Earl . . . . *Bunker Hill, Ill.*
Thomy, Lawrence . . . . *St. Louis, Mo.*
Tragitt, Edmund Rowland . . . . *Rolla, Mo.*
Wailes, Ronald David . . . . *Eaton, Col.*
Walling, William Henry Seward . . . . *Dayton, Wyo.*
Wanenmacher, Joe Melching . . . . *Steubenville, O.*
Watkins, Marion Whitfield . . . . *Memphis, Tenn.*
Weigel, Melvin Powell . . . . *Fredericktown, Mo.*
Weimer, Walter Henry . . . . *Girard, Kan.*
Wendell, Everett John . . . . *Peoria, Ill.*
Wilkerson, Augustus Benton . . . . *Aurora, Mo.*
Wilson, Edgar Mark . . . . *Caney, Kan.*
Zeller, George August . . . . *St. Louis, Mo.*
Zevallos, Robert Cavero . . . . *Callao, Peru.*
Ziegler, William Clark . . . . *Providence, R. I.*
Zoller, Henry Eugene . . . . *Tulsa, Okla.*
Zook, Samuel Irwin . . . . *Buffalo, Kan.*

Metallurgy

Gray, Fred Edwin . . . . *Moran, Kan.*
Gregg, James Lawrence . . . . *Independence, Mo.*
Helmerichs, John Frederick . . . . *St. Louis, Mo.*
Lapee, Roland Joseph . . . . *Sullivan, Mo.*
Lindgren, Ray Alexander . . . . *Chicago, Ill.*
Linzer, Leo . . . . *New York, N. Y.*
Martin, Guy Verdier . . . . *Rolla, Mo.*
Reeves, John Milton . . . . *Anderson, Ind.*
Webster, Vance Herschel . . . . *Anderson. Ind,*

Civil Engineering

Brown, Paul Macfarlane . . . . *Jefferson City, Mo.*
Dierking, George Thomas . . . . *St. Louis, Mo.*
Frame, Wayne Shannon . . . . *Salesville, O.*
Kasel, Rudolph Gustav . . . . *Washington, Mo.*
Knight, Jesse Ray . . . . *Gallatin, Mo.*
Nawn, George Francis . . . . *Rolla, Mo.*

Porter, Edwin Kemp . . . . *Holden, Mo.*
Stuart, Samuel Henry . . . . *Rolla, Mo.*
Tevis, Charles Cyrus . . . . *Holden, Mo.*
Werner, Walter August . . . . *St. Louis, Mo.*
Westgard, James Arne . . . . *Rolla, Mo.*

Mechanical Engineering

Andrews, John Lewis . . . . *Rolla, Mo.*
Bowman, Kingston Miller . . . . *Keokuk, Ia.*
Deckmeyer, Fred August . . . . *St. Louis, Mo.*
Fipps, Elba Lafayette . . . . *Salem, Mo.*
Joslin, Verne George . . . . *Rolla, Mo.*
Meinecke, Egmont Samuel . . . . *Bay, Mo.*
Wilmesherr, Charlie Frank . . . . *Cuba, Mo.*

Electrical Engineering

Schott, Theodore Christ . . . . *Jefferson City, Mo.*
Wells, Harry . . . . *St. James, Mo.*

Chemical Engineering

Bryan, Jean Paul . . . . *Independence, Mo.*
Chappuis, Alfred Starkloff . . . . *St. Louis, Mo.*
Garretson, Walter Paul . . . . *Carthage, Mo.*
Gatts, William Prescott . . . . *Hannibal, Mo.*
Keeling, William Miller . . . . *Falls City, Neb.*
Mennie, Billy Raymond . . . . *Hannibal, Mo.*
Mosby, Donald Speed . . . . *Jefferson City, Mo.*

CLASS OF 1924

Algermissen, Sylvester Cornelius . . . . . . *Montgomery, Mo.*
Backer, William Henry . . . . *Webster Groves, Mo.*
Barnard, Herbert Elery . . . . *St. Louis, Mo.*
Barnett, William Jackson . . . . *Bristow, Okla.*
Baumgardner, Benjamin Kent . . . . *Rolla, Mo.*
Blake, Philip Leroy . . . . *Lynn, Mass.*
Blickensderfer, John . . . . *Lebanon, Mo.*
Ballinger, Ross Angelo . . . . *Gallatin, Mo.*
Buck, Albert Edward . . . . *Central Falls, R. I.*
Campbell, Jack Percy . . . . *Doniphan, Mo.*
Carlton, Hal Hopper . . . . *Sigourney, Ia.*
Carter, Ross Ashford . . . . *Bronaugh, Mo.*

Casey, Walter Eric . . . . *Ramsey, Ill.*
Castelli, Joseph . . . . *Knobview, Mo.*
Christopher, James. . . . . *Warrensburg, Mo.*
Courtney, Robert Munson . . . . *Hannibal, Mo.*
Davidson, Robertson Van Arsdale. . . . *Cherryvale, Kan.*
Davis, Carl Bailey . . . . *Rolla, Mo.*
Drouot, Harold Roberts . . . . *Tulsa, Okla.*
Eble, Otto Hugh. . . . . *Jefferson City, Mo.*
Ellis, Clarence Frederick . . . . *Dallas, Texas.*
Fishburn, Clare Downing . . . . *Carthage, Mo.*
Fitzmaurice, Timothy Beeler . . . . *St. Joseph, Mo.*
Foran, Leo Anson . . . . *Sorento, Ill.*
Gabler, George Charles . . . . *Coffeyville, Kan.*
Graham, William Schley . . . . *Spring Creek, Mo.*
Greensweight, Arnold Sylvister . . . . . . *Rolla, Mo.*
Harris, Emily . . . . *Rolla, Mo.*
Haywood, Elbridge Gerry . . . . *South Centralia, Ill.*
Hedberg, Alvor . . . . *Chicago, Ill.*
Heidtman, Homer Henry . . . . *Wright City, Mo.*
Horrom, Dalton David . . . . *Rolla, Mo.*
Howald, Leon Sidney. . . . . *Rolla, Mo.*
Hunt, Arlo Lowell . . . . *Independence, Mo.*
Hunt, Joseph Owen . . . . *Hannibal, Mo.*
Hooper, Elmo . . . . *Cherryvale, Kan.*
Jett, James Everett . . . . *Rolla, Mo.*
Karr, Edward . . . . *Belleville, Ill.*
Kemper, Claude . . . . *St. Louis, Mo.*
Kenning, Russell Heywood. . . . . *Hannibal, Mo.*
Kessler, Harry Harvey . . . . *St. Louis, Mo.*
Levinson, Arthur Aaron . . . . *Chicago, Ill.*
Loevy, Donald Boehm . . . . *St. Louis, Mo.*
Luster, Thomas Cleveland . . . . *Chickasha, Okla.*
Magalis, Cyrus West . . . . *Dallas, Texas.*
Marek, Charles Harry . . . . *Sioux City, Ia.*
Metcalf, Clyde Sherry . . . . *Greenfield, Ill.*
Mikell, Waring . . . . *Augusta, Ga.*
Monahan, Foster Francis Murray. . . . *Sapulpa, Okla.*
Moodie, Dwight Linford . . . . *St. Louis, Mo.*
McCarthy, James . . . . *Hannibal, Mo.*
McClelland, Myron . . . . *Centralia, Ill.*
McRae, Margaret . . . . *Rolla, Mo.*
Naylor, Archie Waugh. . . . . *Rolla, Mo.*
Powell, William Alvis. . . . . *Lee's Summit, Mo.*
Remmers, Walter Edward . . . . *St. Louis, Mo.*
Roese, David Franklin . . . . *Syracuse, N. Y.*
Runge, Albert Erwin . . . . *Kirkwood, Mo.*
Samples, Bourke . . . . *Boonville, Ind.*

Schaefer, Christian Frederick, Jr. . . . . . *Edgewood, Pittsburg, Pa.*
Schapiro, Leo . . . . *Chicago, Ill.*
Schramm, Herbert Oscar . . . . *Elmhurst, L. I.*
Sitzler, Carl W. B. . . . . *St. Louis, Mo.*
Smith, Carleton . . . . *Richmond, Ind.*
Stover, Curtis Edward . . . . *E. St. Louis, Ill.*
Strong, Frank Noble . . . . *Marshfield, Mo.*
Sublet, Ira . . . . *Texarkana, Tex.*
TenEyck, Warren Everett . . . . *St. James, Mo.*
Thompson, Peter Fergus . . . . *Goodland, Kan.*
Tirre, Milton Frank . . . . *St. Louis, Mo.*
Underwood, Fred James . . . . *Rolla, Mo.*
Walker, Arthur Wellesley . . . . *East Orange, N. J.*
Walker, John Rawlings . . . . *Roodhouse, Ill.*
Wallace, John Festus . . . . *Clearmont, Mo.*
Walls, Cecil Albert . . . . *McAlester, Okla.*
Wasmund, James Marvin . . . . *Vinita, Okla.*
Wilson, Roy Ottis . . . . *Boonville, Ind.*
Wright, Wilford Stillman . . . . *Sedalia, Mo.*
Zimmermann, Desiderius . . . . *St. Louis, Mo.*

SPECIAL STUDENTS

Anderson, Allan James . . . . *Cobalt, Canada.*
Badollet, Dorothy Katherine . . . . *Rolla, Mo.*
Beagles, Harry . . . . *Nevada, Mo.*
Blankenship, David Alderson . . . . *Beckley, W. Va.*
Collet, Charles John . . . . *Columbus, Ohio.*
Cornwell, Benjamin Sedgely . . . . *St. Louis, Mo.*
Dent, Hazel . . . . *Rolla, Mo.*
Dougherty, John Herman . . . . *Peoria, Ill.*
Ewing, Harold Kline . . . . *Macon, Mo.*
Ferer, Hyman . . . . *St. Louis, Mo.*
Gale, Richard Thomas . . . . *Rolla, Mo.*
Graham, William Schley . . . . *Spring Creek, Mo.*
Harris, Jim Van . . . . *Morley, Mo.*
Hodges, Wilfred Horace . . . . *Bridgeport, W. Va.*
Horrom, Dalton David . . . . *Rolla, Mo.*
Hunter, Charles Edward . . . . *Rolla, Mo.*
Kiskaddon, Charles Graham . . . . *Tulsa, Okla.*
McClurken, Russell Craig . . . . *St. Louis, Mo.*
Parker, Robert Leo . . . . *Rolla, Mo.*
Reinoehl, Clyde Oscar . . . . *Rolla, Mo.*
Sanders, Eugene Barnard . . . . *St. Louis, Mo.*
Schuman, Ruth Esther . . . . *Rolla, Mo.*
Scott, Arthur . . . . *Rolla, Mo.*
Scott, Guy Robert . . . . *Diamond, Mo.*

Squires, Glenn Robert . . . . *Carthage, Mo.*
Stebbins, Willard Robert . . . . *Rolla, Mo.*
Thompson, Thomas Maffet . . . . *Goodland, Kan.*
Whitney, Henry McLeod . . . . *Kansas City, Mo.*
Wyant, Madge . . . . *Rolla, Mo.*

SUMMER SCHOOL STUDENTS, 1920

Albert, Hyman Isadore . . . . *St. Louis, Mo.*
Alton, William Joseph . . . . *Columbia, Mo.*
Badollet, Marion Smith . . . . *Rolla, Mo.*
Baxter, William Hampton . . . . *Washington, D. C.*
Bedell, Milo Nanson . . . . *St. Louis, Mo.*
Bisch, Felix Grover . . . . *Bonne Terre, Mo.*
Blankenship, David Alderson . . . . *Beckley, W. Va.*
Bloom, George Barnett . . . . *Maysville, Mo.*
Bolt, William Weeks . . . . *Springfield, Ill.*
Booker, Karl William . . . . *Kansas City, Mo.*
Boyle, Alfred Arthur . . . . *St. Louis, Mo.*
Brant, Raymond Freeman . . . . *Chillicothe, Mo.*
Bruce, Robert . . . . *Wellington, Kan.*
Burke, Stephen Michael . . . . *St. Louis, Mo.*
Cairns, Arthur Lee . . . . *Cape Girardeau, Mo.*
de Cardenas, Emilio . . . . *La Paz, Bolivia.*
Castelli, Joseph . . . . *Knobview, Mo.*
Chapin, Elmer Fenton . . . . *East St. Louis, Ill.*
Coakley, John Leonard . . . . *Kansas City, Mo.*
Cope, Oliver Carroll . . . . *St. Louis, Mo.*
de Cousser, Kurt Herman . . . . *Rolla, Mo.*
Crawford, Howard Stanley . . . . *Rivera, Cal.*
Davis, Carl Bailey . . . . *Rolla, Mo.*
Dunlop, William Harry . . . . *Beardstown, Ill.*
Engelage, Victor Frederick . . . . *Syracuse, Mo.*
Erickson, Roy Oscar . . . . *Madrid, Ia.*
Evans, Owen Richard . . . . *Granger, Mo.*
Farmer, Samuel Dewitt . . . . *Galena, Kan.*
Fischlowitz, Victor Kopple . . . . *St. Louis, Mo.*
Frey, Muir Luken . . . . *Bunker Hill, Ill.*
Frillman, Florian Louis . . . . *St. Louis, Mo.*
Greenwood, Gilbert Gordon . . . . *Perth, Kan.*
Guy, Earl McKinley . . . . *Davenport, Ia.*
Hammer, Bernard Eli . . . . *Stanton, Mo.*
Hayes, Stanley Merton . . . . *Wellsville, Mo.*
Healy, Michael Vincent . . . . *Macon, Mo.*
Hoffman, Ralph Andrew . . . . *Reno, Ohio.*
Hollar, Percy Alvin . . . . *Topeka, Kan.*
Hollow, Francis Herron . . . . *Cuba, Mo.*
Howald, Leon Sidney . . . . *Rolla, Mo.*

Howard, Max Raymond . . . . *Springfield, Mo.*
Hubbard, Henry Guernsey . . . . *Woods Hole, Mass.*
Huckins, Julian Greenway . . . . *Kirkwood, Mo.*
Hurst, Henry William . . . . *Kansas City, Mo.*
Illidge, Robert Eugene . . . . *Corbett, Ore.*
Johnson, Richard Love . . . . *Henryetta, Okla.*
Jones, James Ewart . . . . *Maysville, Mo.*
Kahlbaum, William . . . . *Rolla, Mo.*
Kaullen, Fred Adam . . . . *Jefferson City, Mo.*
Keeler, Edgar Allen . . . . *Tulsa, Okla.*
Keeler, William Weaver . . . . *Tulsa, Okla.*
Kimble, Delar . . . . *St. Louis, Mo.*
Knight, Ralph Henry . . . . *St. Louis, Mo.*
Kratz, Francis Oliver . . . . *Iola, Kan.*
Kruse, Edward Conrad . . . . *St. Louis, Mo.*
Lambdin, Delta Fay . . . . *Lockwood, Mo.*
Lapee, Roland Joseph . . . . *Sullivan, Mo.*
Lee, Pao-Ho . . . . *Chi-Yuan, Honan, China.*
Lenox, Jennie Lynn . . . . *Rolla, Mo.*
Linzer, Leo . . . . *New York City.*
Lumpkin, Lloyd Earl . . . . *Jefferson City, Mo.*
Ma, Heng Yung . . . . *Anyang, Honan, China.*
Machin, Edwin Gilbert . . . . *Bluffton, Mo.*
Meier, Gordon . . . . *Kirkwood, Mo.*
Miller, Edwin Lawrence, Jr . . . . *Kansas City, Mo.*
Miller, John Gains . . . . *Marshall, Mo.*
Mize, Charles Roderick . . . . *Independence, Mo.*
Mosena, Charles Clifford . . . . *Falls City, Neb.*
Mudd, Oscar Peyton . . . . *Wellston, Mo.*
Mundt, Herbert William . . . . *St. Louis, Mo.*
Murphy, Raymond Edward . . . . *Galena, Ill.*
Mutz, Herman Jacob . . . . *Elizabethtown, N. M.*
McClellan, Maurice Hunter . . . . *Eminence, Mo.*
McDonnell, Joseph Michael . . . . *St. Louis, Mo.*
Nevedomsky, Samuel Leonard . . . . *St. Louis, Mo.*
Nudelman, Barney . . . . *St. Louis. Mo.*
O'Hara, Samuel Burl . . . . *Rosendale, Mo.*
Ore, Felipe . . . . *Lima, Peru.*
Oster, John Peter . . . . *Jefferson City, Mo.*
Owens, Irwin King . . . . *St. Louis, Mo.*
Packman, Nathan . . . . *St. Louis, Mo.*
Parker, Robert Leo . . . . *Rolla, Mo.*
Quilliam, William Reed . . . . *Fowlerton, Tex.*
Rembert, Ernest Wayne . . . . *Jefferson City, Mo.*
Righthouse, James Shelby . . . . *Iola, Kan.*
Ruoff, Carl Mathews . . . . *Hannibal, Mo.*
Sanders, James Lewis . . . . *Doniphan, Mo.*

Shaw, Frederick William. . . . . *Rolla, Mo.*
Sherwood, Theodore Clayton. . . . . *Kansas City, Mo.*
Shih, Hsin-Pu . . . . *Chi-Yuan, Honan, China.*
Siegle, William . . . . *St. Louis, Mo.*
Smith, Elwood Temple . . . . *Kansas City, Mo.*
Smith Ralph Day . . . . *Hutchinson, Kan.*
Southern, Christopher . . . . *Kansas City, Mo.*
Squires, Glenn Robert . . . . *Joplin, Mo.*
Stewart, William Lincoln, Jr.. . . . . *Pittsburgh, Pa.*
Stubbins, John Russell . . . . *Paris, Mo.*
Stubbs, Robert Newton, Jr. . . . . *Kirkwood, Mo.*
Sullivan, Robert . . . . *St. Louis, Mo.*
Torrence, Edward, Jr. . . . . *St. Louis, Mo.*
Turner, Harlin Lionel . . . . *Moberly, Mo.*
Updike, Donald Foster . . . . *Plainfield, N. J.*
Weldon, Elzia Bryan. . . . . *Freemont, Mo.*
Whitaker, Robert Adrian . . . . *St. Louis, Mo.*
Wynn, Clarence Marion . . . . *Rolla, Mo.*
Yeager, Robert Lee . . . . *Joplin, Mo.*
Yelton, Iva . . . . *Rolla, Mo.*
Zevallos, Robert Cavero . . . . *Callao, Peru.*
Zink, Robert Earl. . . . . *Independence, Mo.*
Zogg, Martin Florian. . . . . *Granby, Mo.*
Zook, Samuel Irwin . . . . *Buffalo, Kan.*

VOCATIONAL STUDENTS

Alton, William Joseph . . . . *Columbia, Mo.*
Balch, George James . . . . *Jamaica Plain, Mass.*
Bisch, Felix Grover . . . . *Bonne Terre, Mo.*
Brant, Raymond Freeman . . . . *Chillicothe, Mo.*
Burke, Edward Harry . . . . *St. Louis, Mo.*
Campbell, Chester Wilber . . . . *Sedalia, Mo.*
Carey, John William, Jr.. . . . . *St. Louis, Mo.*
Cassil, Lawrence . . . . *Mountain Grove, Mo.*
Chapin, Elmer Fenton. . . . . *East St. Louis, Ill.*
Coakley, John Leonard . . . . *Kansas City, Mo.*
Cope, Oliver Carroll. . . . . *St. Louis, Mo.*
Cummins, Fred . . . . *St. Louis, Mo.*
Edwards, James Carter . . . . *Jefferson City, Mo.*
Evans, Otto Henry. . . . . *Meta, Mo.*
Evans, Owen Richard . . . . *Granger, Mo.*
Farmer, Samuel Dewitt. . . . . *Galena, Kan.*
Fipps, Elba Lafayette . . . . *Salem, Mo.*
Hamilton, Dallas Edward . . . . *St. Louis, Mo.*
Hayes, Stanley Merton . . . . *Wellsville, Mo.*

Hazelwood, Ivan Floyd . . . . *Alton, Ill.*
Healey, Edward Lawrence . . . . *Creston, Ia.*
Hollar, Percy Alvin . . . . *Topeka, Kan.*
Howard, Max Raymond . . . . *Springfield, Mo.*
Huckins, Julian Greenway . . . . *Kirkwood, Mo.*
Johnson, Allen Bernard . . . . *Springfield, Mo.*
Jones, Harry Paul . . . . *Perry, Ia.*
Kibler, Byron Lee . . . . *Sarona, Wis.*
Kimble, Delar . . . . *St. Louis, Mo.*
Kratz, Francis Oliver . . . . *Iola, Kan.*
Kruse, Edward . . . . *St. Louis, Mo.*
Lapee, Roland Joseph . . . . *Sullivan, Mo.*
Lawrence, Hiram Pettibone . . . . *Norfolk, Conn.*
Lepper, Lewis . . . . *Marlboro, Mass.*
Lindenberger, Harvey . . . . *Rantoul, Kan.*
Lowd, Francis Elliot . . . . *Boston, Mass.*
May, John Joseph . . . . *Arlington Heights, Mass.*
Milsted, Harry Stephen . . . . *Rolla, Mo.*
McDonnell, Joseph Michael . . . . *St. Louis, Mo.*
Napper, Herbert Ivy . . . . *Cabool, Mo.*
Neuwirth, Alois George . . . . *St. Louis, Mo.*
O'Brien, Thomas James . . . . *St. Louis, Mo.*
O'Hara, Samuel Burl . . . . *Rosendale, Mo.*
Oster, John Peter . . . . *Jefferson City, Mo.*
Owens, Irwin King . . . . *St. Louis, Mo.*
Phillips, Wendell . . . . *Frederickburg, Ia.*
Pirtle, Oscar Paul . . . . *Chariton, Ia.*
Riddle, John . . . . *Abilene, Kan.*
Rucker, Ambrose Chockley . . . . *Keytesville, Mo.*
Sanders, James Lewis . . . . *Doniphan, Mo.*
Schneeberger, Fred . . . . *Webster Groves, Mo.*
Shepherd, Fred William . . . . *Wichita, Kan.*
Shupe, Walter . . . . *Chariton, Ia.*
Siegle, William . . . . *St. Louis, Mo.*
Smith, Elwood Temple . . . . *Kansas City, Mo.*
Southern, Christopher . . . . *Kansas City, Mo.*
Spitzenberg, Harry Ludwig . . . . *St. Louis, Mo.*
Stover, Curtis Edward . . . . *E. St. Louis, Ill.*
Sullivan, Robert . . . . *St. Louis, Mo.*
Tedford, Donald Samuel . . . . *Diamond, Mo.*
Turner, Cecil Abraham . . . . *Washington, Ia.*
Turner, Harlan Lionel . . . . *Moberly, Mo.*
Valentine, Herman Frederick . . . . *Marshall, Mo.*
Venable, Norman . . . . *Herrick, Ill.*
Walling, William Henry Seward . . . . . . *Dayton, Wyo.*
Whitworth, Virgil Lee . . . . *Nevada, Mo.*

Williams, Gordon . . . . *Joplin, Mo.*
Wynn, Clarence Marion . . . . *Tulsa, Okla.*
Yeager, Robert Lee . . . . *Joplin, Mo.*
Zink, Robert Earl . . . . *Independence, Mo.*
Zogg, Martin Florian . . . . *Granby, Mo.*
Zook, Samuel Irwin . . . . *Buffalo, Kan.*

SUMMARY 1920-1921

Graduate Students		11
Class of 1921:		
Mine Engineering	30	
Metallurgy	8	
Civil Engineering	4	
General Science	2	
Mechanical Engineering	0	
Electrical Engineering	2	
Chemical Engineering	4	50
Class of 1922:		
Mine Engineering	48	
Metallurgy	8	
Civil Engineering	9	
General Science	1	
Mechanical Engineering	1	
Electrical Engineering	3	
Chemical Engineering	4	74
Class of 1923:		
Mine Engineering	67	
Metallurgy	9	
Civil Engineering	11	
General Science	0	
Mechanical Engineering	7	
Electrical Engineering	2	
Chemical Engineering	7	103
Class of 1924		79
Specials		29
Summer School, 1920		111
Federal Board Students:		
Collegiate	11	
Vocational	61	72
Total		529
Counted twice		103
Net		426

BULLETINS OF THE MISSOURI SCHOOL OF MINES

GENERAL SERIES

Vol. 1, No. 1, Dec., 1908. The Human Side of a Mining Engineer's Life. Edmund B. Kirby. (Commencement address, June 10, 1908.)

Vol. 1, No. 2, 38th Annual Catalogue, 1909-1910.

Vol. 1, No. 3, June, 1909. Education for Utility and Culture. Calvin M. Woodward. (Tau Beta Pi address.)

Vol. 1, No. 4, Sept., 1909. The History and Development of the Cyanide Process. Horace Tharp Mann.

Vol. 2, No. 1, Dec., 1909. The Jackling Field, School of Mines and Metallurgy.

Vol. 2, No. 2, 39th Annual Catalogue, 1910-1911. (*Out of print.*)

Vol. 2, No. 3, June, 1910. Some of the Essentials of Success. Charles Summer Howe. (Commencement address, June 1, 1910.)

Vol. 2, No. 4, Sept., 1910. Friction in Small Air Pipes. E. G. Harris, Albert Park, H. K. Peterson. (Continued by Technical Series. Vol. 1, Nos. 1 and 4.)

Vol. 3, No. 1, Dec., 1910. Some Relations Between the Composition of a Mineral and Its Physical properties. G. H. Cox, E. P. Murray.

Vol. 3, No. 2, March 1, 1911. 40th Annual Catalogue, 1911-1912.

Vol. 3, No. 3, June, 1911. Providing for Future Generations. E. R. Buckley. (Tau Beta Pi address, May 24, 1911.)

Vol. 3, No. 4, Sept., 1911. Fall Announcement of Courses. (*Out of print.*)

Vol. 4, No. 1, Dec., 1911. Fortieth anniversary of the School of Mines and Metallurgy of the University of Missouri. Parker Hall Memorial Address. Laying of cornerstone of Parker Hall, Rolla, Missouri, October 24, 1911.

Vol. 4, No. 2, March, 1912. 41st Annual Catalogue, 1912-1913.

Vol. 4, No. 3, June, 1912. Mining and Civilization. J. R. Finlay. (Commencement address, May 31, 1912.)

Vol. 4, No. 4, Sept., 1912. Fall announcement of courses. (*Out of print.*)

Vol. 5, No. 1, Dec., 1912. Student Life.

Vol. 5, No. 2, March, 1913. 42nd Annual Catalogue, 1912-1913.

Vol. 5, No. 3. Never published.

Vol. 5, No. 4. Never published.

Vol. 6, No. 1. Never published.

Vol. 6, No. 2, March, 1914. 43rd Annual Catalogue, 1913-1914.

Vol. 6, No. 3. Never published.

Vol. 6, No. 4. Never published.

Vol. 7, No. 1. Never published.

Vol. 7, No. 2, March, 1915. 44th Annual Catalogue, 1914-1915.

Vol. 7, No. 3, June, 1915. Description of special courses in oil and gas and allied subjects.

Vol. 7, No. 4, Sept., 1915. Register of graduates, 1874-1915.

Vol. 8, No. 1, Jan., 1916. Bibliography on Concentrating Ores by Flotation. Jesse Cunningham.

Vol. 8, No. 2, March, 1916. 45th Annual Catalogue, 1915-1916.

Vol. 8, No. 3, June, 1916. The Business of Mining. W. R. Ingalls. (Commencement address, May 26, 1916.)

Vol. 8, No. 4, Oct., 1916. Register of Graduates, 1874-1916. (*Out of print.*)

Vol. 9, No. 1, Jan., 1917. Road Problems in the Ozarks. E. G. Harris. Bibliography on Rural Roads. H. L. Wheeler.

Vol. 9, No. 2, March, 1917. 46th Annual Catalogue, 1916-1917.

Vol. 9, No. 3, June, 1917. What Should a Present-Day Metallurgical Education Comprise Charles Hermann Fulton. (Commencement address, May 25, 1917.)

Vol. 9, No. 4, Oct., 1917. Register of Graduates, 1874-1917. M. S. M. men in military service.

Vol. 10, No. 1, Jan., 1918. Student Life; Revised Edition.

Vol. 10, No. 2, March, 1918. 47th Annual Catalogue, 1917-1918.

Vol. 10, No. 3, June, 1918. The Human Side of Mining Engineering. James Furman Kemp. (Commencement address, May 24, 1918.)

Vol. 10, No. 4, Oct., 1918. (Delayed.) List of publication wanted by the library, and of duplicates available for sale or exchange, April, 1920.

Vol. 11, No. 1, Jan., 1919. (*In preparation.*)

Vol. 11, No. 2, March, 1919. 48th Annual Catalogue, 1918-1919.

Vol. 11, No. 3, June, 1919. Road Problems in the Ozarks; 2nd edition, revised and extended. G. E. Harris. Bibliography on rural roads. H. L. Wheeler.

Vol. 11, No. 4, October, 1919. Register of Graduates, 1874-1919.

Vol. 12, No. 1, Jan., 1920. War Service Records of the Missouri School of Mines. Compiled by G. E. Ebmeyer.

Vol. 12, No. 2, March, 1920. 49th Annual Catalogue, 1919-1920.

Vol. 12, No. 3, June, 1920. Contemporary Novels and Novelists; A List of References. H. L. Wheeler.

Vol. 12, No. 4, October, 1920. Department of Vocational Education.

Vol. 13, No. 1. (*In preparation.*)

Vol. 13, No. 2, March, 1921. 50th Annual Catalogue, 1920-1921.

TECHNICAL SERIES

Vol. 1, No. 1, Nov., 1911. Friction in Air Pipes. E. G. Harris. (Continuation of General Series, Vol. 2, No. 4.)

Vol. 1, No. 2, Feb., 1912. Metallurgy and Ore Dressing Laboratories of the Missouri School of Mines and Metallurgy. D. Copeland, H. T. Mann, H. A. Roesler. (*Out of print.*)

Vol. 1, No. 3, May, 1912. Some Apparatus and Methods for Demonstrating Rock Drilling and the Loading of Drill-Holes in Tunnelling. L. E. Young.

Vol. 1, No. 4, Aug., 1912. Friction in Air Pipes. E. G. Harris. (Continuation of Vol. 1, No. 1, Nov., 1911.)

Vol. 2, No. 1, Aug., 1915. Comparative Tests of Piston Drill Bits. C. R. Forbes and L. M. Cummings.

Vol. 2, No. 2, Nov., 1915. Orifice Measurements of Air in Large Quantities. Elmo G. Harris.

Vol. 2, No. 3, Feb., 1916. Cupellation Losses in Assaying. Horace T. Mann and Charles Y. Clayton.

Vol. 2, No. 4, May, 1916. Geologic criteria for determining the structural position of sedimentary beds. G. H. Cox and C. L. Dake. (*Out of print.*)

Vol. 3, No. 1, Aug., 1916. Experiments from the Flotation Laboratory. C. Y. Clayton. (*Out of print.*)

Vol. 3, No. 2, Nov., 1916. Studies on the Origin of Missouri Cherts and Zinc Ores. G. H. Cox, R. S. Dean and V. H. Gottschalk.

Vol. 3, No. 3, Feb., 1917. Preliminary Report on Blended Portland Cement. E. S. McCandliss.

Vol. 3, No. 4, May, 1917. Studies in the Production of Oils and Tars from Bituminous Materials. J. C. Ingram.

Vol. 4, No. 1, Aug., 1917. The Hydrometallurgy and Electrolytic Precipitation of Zinc. F. D. James.

Vol. 4, No. 2, Nov., 1917. The Effect of Addition Agents in Flotation. Part I. M. H. Thornberry and H. T. Mann.

Vol. 4, No. 3, Feb., 1918. Bibliography: Roasting, Leaching, Smelting, Electric Smelting and Electrolysis of Zinc. H. L. Wheeler.

Vol. 4, May, 1918. An Investigation of Blended Portland Cement. E. S. McCandliss and H. H. Armsby.

Vol. 5, No. 1, Aug., 1919. The Carbonization of Missouri Cannel Coals. H. L. Dunlap, K. K. Kershner and V. X. Smiley.

Vol. 5, No. 2, Nov., 1919. The Effect of Addition Agents in Flotation. Part II. M. H. Thornberry and H. T. Mann.

Vol. 5, No. 3, Feb., 1921. An Investigation of the Xylenes Obtained from the Carbonization of Coal. W. D. Turner. (*In press.*)

Vol. 5, No. 4, May 1921, Coal Mining Methods in Missouri. W. W. Weigel. (*In Press.*)

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Volume Fourteen Number Two

Catalogue 1921-22

SCHOOL OF MINES AND METALLURGY

UNIVERSITY *of* MISSOURI

BULLETIN

MARCH, 1922

ROLLA, MISSOURI

Entered as Second-Class Matter January 7, 1909, at the Post Office at Rolla, Missouri, under the act of July 18, 1894. Issued Quarterly.

Fifty-first Annual Catalogue

School of Mines and Metallurgy

University of Missouri

Rolla, Missouri

1922

CALENDAR, 1922

JANUARY TO DECEMBER

January

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

S	M	T	W	T	F	S
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5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

March

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	[illegible]
9	10	11	12	13	14	[illegible]
16	17	18	19	20	21	[illegible]
23	24	25	26	27	28	[illegible]
30						

May

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

June

S	M	T	W	T	F	S
				1	2	3
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11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

July

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August

S	M	T	W	T	F	S
		1	2	3	4	[illegible]
6	7	8	9	10	11	[illegible]
13	14	15	16	17	18	[illegible]
20	21	22	23	24	25	[illegible]
27	28	29	30	31		

September

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

November

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December

S	M	T	W	T	F	S
					1	[illegible]
3	4	5	6	7	8	[illegible]
10	11	12	13	14	15	[illegible]
17	18	19	20	21	22	[illegible]
24	25	26	27	28	29	[illegible]
31						

CALENDAR, 1923.

JANUARY TO DECEMBER

January

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
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CALENDAR

1922

WINTER TERM

January 2	Monday, Registration.
February 22	Wednesday, Washington's Birthday, holiday.
April 28	Friday, Commencement Day.

1922

SPRING-SUMMER TERM

April 29	Saturday, Registration.
May 30	Tuesday, Memorial Day.
June 24	Wednesday, Spring-Summer term ends.

1922

FALL TERM

August 23	Wednesday, Entrance Examinations.
August 25-26	Friday, Saturday, Registration.
August 28	Monday, Classes begin.
November 29	Wednesday, 4:00 p. m., Thanksgiving holidays begin.
December 3	Sunday, Thanksgiving holidays end.
December 22	Friday, 4:00 p. m., Christmas holidays begin.

1923

WINTER TERM

January 2	Tuesday, Registration.
February 22	Thursday, Washington's Birthday, holiday.
May 5	Saturday, Commencement Day.

1923

SPRING-SUMMER TERM

The regular Spring-Summer term is discontinued in 1923 and the usual school year of two terms of 18 weeks each is re-established.

BOARD OF CURATORS

With dates of original appointments.

TERM EXPIRES JANUARY 1, 1927

George L. Edwards, 1921 . . . . *St. Louis*
Frank M. McDavid, 1921 . . . . *Springfield*

TERM EXPIRES JANUARY 1, 1923

G. E. Muns, 1917 . . . . *Mongomery City*
P. E. Burton, 1920 . . . . *Joplin*
Milton Tootle, Jr., 1917 . . . . *St. Joseph*

TERM EXPIRES JANUARY 1, 1925

S. L. Baysinger, 1907 . . . . *Rolla*
H. J. Blanton, 1919 . . . . *Paris*
James E. Goodrich, 1919 . . . . *Kansas City*

TERM EXPIRES JANUARY 1, 1927

E. Lansing Ray, 1921 . . . . *St. Louis*

OFFICERS OF THE BOARD

James E. Goodrich . . . . *President*
P. E. Burton . . . . *Vice-President*
Leslie Cowan . . . . *Secretary*
R. B. Price . . . . *Treasurer*

THE EXECUTIVE COMMITTEE

Of the School of Mines and Metallurgy

S. L. Baysinger, Chairman . . . . *Rolla*
Frank M. McDavid . . . . *Springfield*
G. E. Muns . . . . *Montgomery City*
Edward Kahlbaum, Secretary . . . . *Rolla*
E. J. Campbell, Treasurer . . . . *Rolla*

FACULTY

JOHN CARLETON JONES, A. B., A. M., Ph. D., LL. D.,
President of the University.

CHARLES HERMAN FULTON, E. M., D. Sc.,
Director.

AUSTIN LEE McRAE, B. S., Sc. D.,
Emeritus Professor of Physics and Ex-Director.

ELMO GOLIGHTLY HARRIS, C. E.,
Professor of Civil Engineering.

GEORGE REINALD DEAN, B. S., C. E.,
Professor of Mathematics and Registrar.

CARROLL RALPH FORBES, B. S., E. M.,
Professor of Mining.

JOSEPH WAYNE BARLEY, A. B., A. M., Ph. D.
Professor of English and Modern Languages.

WILLIAM DeGARMO TURNER, B. S., Ph. D.
Professor of Chemistry.

LEON ELMER WOODMAN, A. B., A. M., Ph. D.,
Professor of Physics.

CHARLES YANCEY CLAYTON, B. S., Met. E.,
Professor of Metallurgy and Ore Dressing.

CHARLES LAURENCE DAKE, B. A., M. A., Ph. D.,
Professor of Geology.

CHARLES EDWARD COOKE, Topographic Eng., U. S. G. S.,
Professor of Topographic Engineering.

LEON ELLIS GARRETT, B. S.,
Professor of Mechanics.

HARVEY ODEN GARST, B. S.,
Professor of Highway Engineering.

R. O. JACKSON, B. S.,
Professor of Mechanical Engineering.

WALTER LYMAN MEDDING, B. S., Capt. Corps of Engineers, U. S. A.,
Professor of Military Science and Tactics.

WARREN SCOTT BOYCE, A. B., A. M., Ph. D.,
Professor of Economics.

FRANK EDWARD DENNIE, B. S.,
Associate Professor of Physical Education and Director of Athletics.

HENRY HORTON ARMSBY, B. S., C. E.,
Associate Professor of Civil Engineering and Student Adviser.

HOWARD LEROY DUNLAP, B. S., M. A.,
Associate Professor of Chemistry.

FREDERICK WILLIAM SHAW, M. D., B. S., M. S.
Associate Professor of Hygiene and Student Health Adviser.

THOMAS MELLOR BAINS, Jr., E. M.,
Associate Professor of Metallurgy.

FLOYD HILL FRAME, A. B.,
Associate Professor of Electrical Engineering.

JOSEPH RAMON GUITERAS, E. M.,
Associate Professor of Mining.

CLAIR VICTOR MANN, B. S., C. E.,
Associate Professor of Mechanical Drawing and Descriptive Geometry.

GARRETT A. MUILENBURG, B. A., M. S.,
Associate Professor of Geology and Mineralogy.

EUGENE LEE JOHNSON, Ph. B., LL. B.,
Assistant Professor of English and Secretary to the Faculty.

JOSIAH BRIDGE, A. B., M. S.,
Assistant Professor of Geology.

RYLAND FLETCHER RATLIFF, A. B., A. M.,
Assistant Professor of Physics.

CLARENCE EDWARD BARDSLEY, B. S.,
Assistant Professor of Topographic Engineering.

ROGER McCUNE, B. S.,
Assistant Physical Director.

OSCAR ADAM HENNING, A. B., A. M.,
Assistant Professor of German.

KARL KENNETH KERSHNER, B. S., M. S.,
Assistant Professor of Chemistry.

RALPH VINCENT PRITCHARD, B. S.,
Assistant Professor of Mathematics.

JAMES HENRY UNDERWOOD,
Assistant Professor of Shop.

STERLING PRICE BRADLEY, B. S.,
Assistant Professor of English.

ISRAEL HERRICK LOVETT, B. S.,
Assistant Professor of Electrical Engineering.

WILLIAM WESLEY WANAMAKER, 1st Lieutenant, Corps of Engineers, U. S. A.,
Assistant Professor of Military Science and Tactics.

CLARENCE JOHN MONROE, B. S., Ph. D.,
Assistant Professor of Chemistry.

VAN BUREN HINSCH, B. S., E. M.,
Instructor in Mathematics.

ARTHUR SCOTT, Master Sergeant, U. S. A.,
Instructor in Military Science and Tactics.

JOE BEATY BUTLER, B. S.,
Instructor in Civil Engineering.

CELESTIN PIERRE CAMBIAIRE, A. B., Ph. B.,
Instructor in Spanish and French.

EDMUND HUGH WOOLRYCH,
Instructor in Drawing.

VICTOR KOPPLE FISCHLOWITZ, B. S.,
Instructor in Mathematics.

WILLARD BARTLETT BREWER,
Instructor in Topographic Engineering.

THADDEUS THORNDIKE RANNEY,
Instructor in Topographic Engineering.

ERNEST E. DECKER,
Instructor in Topographic Engineering.

BARNEY NUDELMAN, B. S., M. S.,
Instructor in Chemistry.

SAMUEL HORACE LLOYD, Jr., A. B., M. S.,
Instructor in English.

DONALD FOSTER UPDIKE, B. S.,
Instructor in Metallurgy and Mechanics.

WALTER CHARLES ZEUCH, B. S.,
Instructor in Highway Engineering.

LEWIS L. McKIMMEY, Master Signal Electrician, U. S. A.,
Assistant to Professor of Military Science and Tactics.

WESLEY BARRINGTON MILLER, B. S.,
Instructor in Mechanical Engineering.

T. G. MacCARTHY, C. E.,
Instructor in Civil Engineering.

A. L. CAIRNS, B. S.,
Assistant in Metallurgy.

FRED LANE,
Assistant in Chemistry,

W. A. COREY,
Assistant in Shop.

OTHER OFFICERS

EDWARD KAHLBAUM,
Business Manager.

ROBERT RICHMOND DICKERSON,
Superintendent of Buildings and Grounds.

ZELLA ELIAS,
Secretary to the Director,

MARGUERITE IRISH NORVILLE, Graduate St. Louis Library School,
Acting Librarian.

HOWARD J. TEAS,
Coordinator, Veterans' Bureau.

NANCY HARRISON HAYES,
Assistant Librarian.

EDITH CARTER JOHNSON,
Cataloguer.

ELIZABETH MONTGOMERY,
Stenographer.

MABEL ZEUCH,
Stenographer.

EVA MAY UNDERWOOD,
Stenographer.

ELLA HART,
Stenographer.

LEONTINE MEGLITSCH,
Stenographer.

GLADYS LOVE COPE,
Stenographer.

ADA SANDER,
Stenographer Veterans' Bureau.

STAFF OF THE STATE MINING EXPERIMENT STATION

Co-operating with the Bureau of Mines.

MARTIN HARMON THORNBERRY, B. S., Met. E.,
Research Metallurgist in charge of station.

THOMAS MELLOR BAINS, Jr., E. M.,
Research Metallurgist.

WILLIAM McKINLEY KAHLBAUM, B. S.,
Chemist.

JOSEPH HENRY BOWEN,
Master Mechanic.

J. L. GREGG,
Assistant Chemist.

NELLIE BISHOP,
Stenographer.

GRADUATE ASSISTANTS

Huston Taylor . . . . *Chemistry*
E. W. Rembert . . . . *Chemistry*
M. J. Ingerson . . . . *Geology*
M. W. Wallace . . . . *Physics*
R. K. Stroup . . . . *Mining*
C. J. Millar . . . . *Hygiene*

BUREAU OF MINES FELLOWS

Clarence W. Burkhart . . . . *Electrometallurgy*
Elmer List . . . . *Ore Dressing*
Joseph H. Rohloff . . . . *Physical Metallurgy*
Richard J. Stroup . . . . *Mining*

STUDENT ASSISTANTS

Edward Torrence, Jr.	*Director's Office*
W. H. Dunlop	*Metallurgy*
K. M. Bowman	*Mathematics*
N. M. Rountree	*Civil Engineering*
W. A. Werner	*Civil Engineering*
E. G. Machin	*Civil Engineering*
G. T. Dierking	*Civil Engineering*
James McCarthy	*Civil Engineering*
W. S. Frame	*Civil Engineering*
P. M. Brown	*Civil Engineering*
A. E. Buck	*Civil Engineering*
P. L. Blake	*Drawing*
G. R. Scott	*Drawing*
R. A. Lindgren	*Drawing*
W. C. Lay	*Physics*
D. L. Moodie	*Drawing*
J. F. Hosterman	*Drawing and Physical Laboratory*
S. K. Reid	*Registrar's Office*
Ralph Knight	*Chemistry*
W. O. Keeling	*Chemistry*
C. C. Mosena	*Chemistry*
Joseph Castelli	*Chemistry*
M. P. Weigel	*Chemistry*
A. F. Denison	*Mining*
I. F. Hodges	*Mining*
J. T. Hodges	*Mining*
M. L. Frey	*English*
J. P. Bryan	*English*
V. H. Webster	*Library*
D. G. Gibson	*Library*
K. Teller	*Library*
W. E. Case	*Physics*
W. Mikell	*Hygiene*
J. L. Bulger	*Gymnasium*
H. E. McBride	*Gymnasium*
M. I. Signer	*Gymnasium*
G. J. Christner	*Gymnasium*
H. H. Kessler	*Gymnasium*
W. H. Metzger	*Geology*
J. E. Jewell	*Geology*
J. P. Gordon	*Geology*
E. M. Guy	*Vocational*

J. G. Miller	*Vocational*
H. L. Leonard	*Vocational*
B. M. Layton	*Vocational*
H. S. Pence	*Vocational*
D. B. Jett	*Vocational*
J. Worley	*Vocational*
K. deCousser	*Vocational*
C. B. Kaley	*Vocational*
W. R. Denison	*Vocational*
F. K. M. Hunter	*Vocational*
A. A. Boyle	*Vocational*
H. R. Powers	*Vocational*
W. W. Bolt	*Vocational*

FACULTY COMMITTEES.

Secretary of the Faculty

PROFESSOR JOHNSON

Committee on Policy

FULTON, BARLEY, CLAYTON, COOKE, DAKE, DEAN, FORBES, GARRETT, HARRIS, JACKSON, TURNER, WOODMAN, ARMSBY, DENNIE, MANN, SHAW, BOYCE, MEDDING

Committee on Credits

DEAN, BARLEY, TURNER, LOVETT, MUILENBURG

Committee on Registration

DEAN, ARMSBY, DAKE, MANN, FRAME

Committee on Discipline

BARLEY, FORBES, WOODMAN, GARRETT

Committee on Curricula

FORBES, CLAYTON, TURNER, HARRIS, JACKSON, DAKE, RATLIFF

Committee on Graduate Students

TURNER, DEAN, WOODMAN, GUITERAS

Committee on Athletics and Physical Education

CLAYTON, DENNIE, SHAW, THORNBERRY, WANAMAKER

Committee on Military Drill

MEDDING, WANAMAKER, DENNIE, BAINS

Committee on Student Activities

ARMSBY, BOYCE, KERSHNER, PRITCHARD

Committee on Publications

TURNER, MRS. NORVILLE, CAMBIAIRE, HENNING

ESTABLISHMENT AND STATUTES OF MISSOURI APPLYING TO THE SCHOOL OF MINES

The University of Missouri was established by an act of the General Assembly of the State of Missouri, approved February 11, 1839, two days after the act establishing the public school system of the state was approved.

The University was located at Columbia, Boone County, June 24, 1839. The cornerstone of the main building was laid July 4, 1840. The spring following, April 14, 1841, instruction in academic courses was begun. The first class, consisting of two members, was graduated in 1843. Women were first admitted to the University in 1869.

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College at Columbia and a School of Mines and Metallurgy in Southeast Missouri.

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The first class of three members was graduated in 1874.

Extracts from Revised Statutes of Missouri, 1919.

Sec. 11523. Corporate Name and Powers—Eminent Domain.—The university is hereby incorporated and created a body politic, and shall be known by the name of "The curators of the University of Missouri," and by that name shall have perpetual succession, power to sue and be sued, complain and defend in all courts; to make and use a common seal, and to alter the same at pleasure; to take, purchase and to sell, convey and otherwise dispose of lands and chattels; to condemn and appropriate real estate or other property, or any interest therein, for any public purpose within the scope of its organization, in the same manner and with like effect as is provided in chapter 13, article II of the Revised Statutes of 1919: Provided, that if the curators so elect, no assessment of damages or compensation under this article shall be payable, and no execution shall issue before the expiration of sixty days after the adjournment of the next regular session of the legislature held after such assessment is made, but the same shall bear interest at the rate of six per cent per annum from its date until paid; and provided further, that the curators may, at any time, elect to abandon the proposed appropriation of property by an instrument of writing to that effect, to be filed with the clerk of the court and entered on the minutes of the court, and as to so much as is thus abandoned, the assessment of damages or compensation shall be void: Provided, that the curators shall not have power to sell or convey any land contained within the university campus.

Sec. 11524. Curators, Number of and How Appointed.—The Board of Curators of the University of the State of Missouri shall hereafter consist of nine members, who shall be appointed by the governor, by and with the advice and consent of the senate: Provided, that not more than one person shall be appointed upon said board from the same congressional district, and no person shall be appointed a curator who shall not be a citizen of the United States, and who shall not have been a resident of the State of Missouri two years next prior to his appointment. Not more than five curators shall belong to any one political party.

Sec. 11525. The Term of Service—Classification—Compensation.—The term of service of the curators shall be six years, the terms of three expiring every two years, the first expiration occurring on the first day of January, 1911, and succeeding expirations of three members every two years thereafter. Said curators, while attending the meetings of the board, shall receive their actual expenses, which shall be paid out of the ordinary revenues of the university.

Sec. 11526. Executive Board—Executive Committee of School of Mines—Duties—Compensation.—The board of curators shall appoint annually three of their number to act as an Executive Board, who shall meet each month for the purpose of auditing claims and attending to such other business as may be intrusted to them by the Board of Curators, not inconsistent with this article. The members of the Executive Board shall receive five dollars per day for each day they shall attend the monthly meetings, together with their actual expenses, to be paid as the expenses of the curators are paid. Said Executive Board shall be subject to change or removal at pleasure of the Board of Curators. The Board of Curators shall also appoint annually three of their number to act as an Executive Committee of the School of Mines and Metallurgy, with like powers and compensation as those of the Executive Board at Columbia. Said Executive Committee shall also be subject to change or removal at pleasure of the Board of Curators.

Sec. 11562. College of Agriculture and School of Mines Established.—There is hereby established a College of Agriculture at Columbia and a School of Mines and Metallurgy at Rolla, provided for by the grant of the congress of the United States, as distinct departments of the University of the State of Missouri.

Sec. 11563. Object of These Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life.

Sec. 11564. Academic Course of Study, Etc.—That the obligation of the State to the general government assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the University of the State of Missouri shall prescribe and adopt a liberal academic course of study to be taught in the School of Mines and Metallurgy located at Rolla, in addition to the courses now taught in said school, and may confer the degree of a bachelor of science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof.

Sec. 11570. Right to Confer Degrees.—The College of Agriculture and the School of Mines and Metallurgy shall have power to confer degrees suitable to their designs and courses of study; and the School of Mines and Metallurgy shall provide courses for, and shall confer the bachelor of science and professional degrees in mining engineering, in metallurgy, in mechanical engineering, in electrical engineering, in chemical engineering, in civil engineering and the degrees of bachelor and master of science in general science.

ENDOWMENT AND MAINTENANCE

1. LAND GRANT.—The proceeds from the sale of 275,000 acres of land granted to Missouri by Act of Congress of July 2, 1862. Most of this land has been sold and the sum invested in State Certificates of Indebtedness, yielding 5 per cent interest, and in municipal and drainage district bonds. The School of Mines receives one-fourth of this income, amounting to $4,588.52 annually. (See R. S. 1909, Sec. 11161, and Session Acts, 1911, p. 415.)

2. MORRILL BILL.—An annual appropriation of $50,000 by Act of Congress, approved August 30, 1890. One-sixteenth of this amount is by law appropriated to Lincoln Institute and one-fourth of the remainder, amounting to $11,718.75, to the School of Mines. (See R. S. 1909, Sec. 11171.)

3. SEMINARY FUND.—The proceeds from the sale of land donated to the School of Mines is invested in a State Certificate of Indebtedness of $2,000. The interest on this certificate amounts to $100 annually. (See R. S. 1909, Sec. 11161.)

4. DIRECT TAX ENDOWMENT.—In 1891 the Government returned to the various states the sums collected from its citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23. The Thirty-sixth General Assembly established this as a permanent endowment to the University and School of Mines. This endowment is invested in a State Certificate of Indebtedness bearing 5 per cent interest. The School of Mines receives one-fifth of this sum, amounting to $6,469.58. (See R. S. 1909, Sec. 11161.)

5. Interest on money derived from the sale of University lands invested in bonds: One-fifth to the School of Mines, amounting annually to $215.00.

6. The funds for the maintenance of the School of Mines are appropriated biennially by the State Legislature.

LOCATION, BUILDINGS AND GROUNDS

LOCATION

The School of Mines and Metallurgy is located at Rolla, Phelps County, on the St. Louis and San Francisco Railroad, one hundred and ten miles southwest of St. Louis.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above sea level, and has an agreeable and notably healthful climate. Its position on a transcontinental railway system makes it readily accessible.

The school is located convenient to the important mining districts of the state, the Southeast Missouri lead district on the one hand, and the Southwest Missouri, Kansas-Oklahoma zinc district on the other. The great oil fields of the southwest are readily accessible, and the school is in close touch with this industry. The location offers exceptional facilities for mining, ore dressing, metallurgy and geology. Missouri stands first in the production of lead, and is the center of an important smelting industry. The great zinc smelters of the Mississippi Valley are located within easy reach. The mineral and metallurgical industries centering in St. Louis, such as clay and brick, cement, alumina, chemical manufactures, lead and zinc smelting, afford excellent facilities for close range study.

The Mississippi Valley Experiment Station of the United States Bureau of Mines has its laboratories in the Metallurgical Building of the School of Mines. The field of this station is the lead and zinc industry of the Mississippi Valley. Through the Experiment Station, with which the State Mining Experiment Station co-operates, the school is brought into intimate contact with the great mineral industry of the Mississippi Valley.

BUILDINGS AND GROUNDS

Rolla Building.—The Rolla Building is the oldest building on the campus. It was built originally by the City of Rolla for a high school, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It now houses the Missouri Bureau of Geology and Mines; Missouri Geological Survey; and contains the library, laboratories drafting rooms, offices and geological collections of the Survey. It is a brick structure ninety feet by sixty feet, three stories and basement high.

Chemical Hall.—This building is used by the Department of Chemistry. The main portion of the building was erected in 1885. Two wings and a second story were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five by sixty feet and one story high. The stock room, twenty-eight feet wide by forty-four feet long, and two stories high, was erected in 1915 During the present year the basement of the south wing was remodeled into a modern laboratory for physical chemistry.

Power Plant.—The Power Plant Building was erected in 1895. It is a tile-roof, press-brick structure built in two parts, one containing offices and laboratories, and the other boiler room, engine room and mechanical engineering laboratory. The boiler room was enlarged in 1909.

Mechanical Hall.—This building was erected in 1901. It is a two-story brick building one hundred fifty feet by sixty feet, and contains the shops of the institution. The first floor is devoted to forge shop, machine shop, stock and tool rooms; the second floor to the wood shop, lecture rooms and drafting room.

Norwood Hall.—This is the main building of the School of Mines and was completed in 1903. It houses the department of physics, electrical engineering, mining, geology, civil engineering, English and mathematics. It is a three-story and basement press-brick, stone-trimmed structure.

Ore Dressing and Metallurgy Building.—This building, completed in 1911, is used by the Department of Metallurgy, and at present also houses the Mississippi Valley Experiment Station of the United States Bureau of Mines. It is a three-story, gray, press-brick building with a basement and two large one-story wings, and contains over twenty-five thousand feet of floor space.

Parker Hall.—Parker Hall is the Administration Building. It is a fire-proof, two-story, gray, press-brick building with a high basement. The main portion of the building is one hundred two by fifty-five feet and the wing is fifty-eight by sixty feet. The library occupies the second floor, the administrative offices and faculty rooms the first floor, and in the wing is the auditorium seating six hundred fifty persons. This auditorium is provided with stage and with moving picture machine. In the basement of the building are located the materials testing laboratories.

The Jackling Gymnasium.—This building was completed in 1915. It is located at the north end of the campus adjoining Jackling Field. The building occupies an area seventy-two feet wide and one hundred twenty-seven feet long and is built of dark red, rough brick with terra-cotta trimmings. The interior is of fire-proof construction. It contains a swimming pool twenty feet by sixty feet in size. The gymnasium is modern in every way. It

contains all the necessary appliances for physical training. In the gallery of the gymnasium is a running track of twenty-six laps to the mile.

Grounds and Athletic Field.—The campus of the School of Mines is situated in the highest part of the City of Rolla and is thirty-two acres in extent. It contains beautiful lawns, groves of native oak and maple shade trees. The Jackling Athletic Field has a baseball diamond, a football gridiron, and a four hundred forty yard running track and tennis courts. The golf links of the school, containing approximately eighty acres, are situated just west of the city limits and within four blocks of the campus.

United States Bureau of Mines

Mississippi Valley Experiment Station.

The laboratories of the Mississippi Valley Experiment Station of the U. S. Bureau of Mines are maintained on the campus.

The staff of the station is as follows:

GEO. J. SALMON,
Acting Superintendent (Aug. 1, 1921, to Jan. 1, 1922).

WILL. H. COGHILL,
Metallurgist.

K. BAUMGARTEN,
Mining Engineer.

B. M. O'HARRA,
Associate Metallurgist.

C. O. ANDERSON,
Assistant Metallurgist.

NOEL HUBBARD,
Principal Clerk.

ALBERT L. JOHNS,
Clerk.
Co-operative staff, detailed from the School.

T. M. BAINS,
Associate Professor of Metallurgy (half time).

WM. M. KAHLBAUM,
Chemist.

J. H. BOWEN,
Mechanic.

E. LIST,
Fellow.

C. W. BURKHART,
Fellow.

J. H. ROHLOFF,
Fellow.

R. J. STROUP,
Fellow.

In addition to the above the following consulting men of the Bureau are located on the campus:

CHAS. H. FULTON,
Consulting Metallurgist.

H. A. BUEHLER,
Consulting Mining Expert.

C. R. FORBES,
Consulting Mining Engineer.

C. Y. CLAYTON,
Consulting Metallurgist.

The activities of this station cover the lead and zinc fields of the Mississippi Valley and deal with such problems as arise in the lead and zinc industry of a mining, ore dressing, or metallurgical nature, and are of a general character, the solution of which would tend to increase the efficiency of the industry and economic development and conservation of the lead and zinc resources in the prevention of waste of such resources in the territory served by the station.

The station is at present located in the Metallurgical Building, but the last session of the state legislature appropriated $100,000 for the purpose of erecting a new building to house this station and the state experiment station. The new building is expected to be ready for occupancy during the late fall of the present year.

During the past year an investigation has been made of the separation of the lead-zinc-fluorspar ore encountered in the lower workings of the fluorspar mines of Southern Illinois and Northern Kentucky, and a report issued suggesting a method of effecting this separation. A study of underground loading devices has been carried on during the past year, and will be continued during the coming year. This involves a study of the different mechanical methods in use in the district for this purpose, this data to be correlated with that obtained from other districts by the Bureau, and a report issued thereon. A study of methods of preventing mineral waste in the Wisconsin zinc fields has been completed and a report issued thereon. The study of the drill steel problem is being carried on. Tests were made in the Tri-State district to determine the practicability of using 1″ steel in the large hammer drills in place of the usual 1½″ steel. The results of these tests indicated that this could be done at a considerable saving to the mine operators. The results of this work were published in Report of Investigations, Serial No. 2297. A study is now being made of drilling tests on

steel to determine what heat treatment gives the best cutting qualities; this latter phase of the work is in co-operation with the North Central Station of the Bureau. An investigation is being made of the electrothermic metallurgy of zinc, and also in connection with this a study of some of the fundamental physical and chemical factors entering into the successful condensation of zinc vapors to liquid metal. An investigation of the milling of Hancock County, Tennessee, zinc ores has been carried out, at the request of the State Geologist of Tennessee. An investigation of the milling problems of the Tri-State field of Missouri, Kansas and Oklahoma is also under way at this time.

THE STATE MINING EXPERIMENT STATION

MARTIN H. THORNBERRY, B. S., Met. E.,
Research Metallurgist, in charge of station.

THOMAS MELLOR BAINS, Jr., E. M.,
Research Metallurgist.

WILLIAM M. KAHLBAUM, B. S.,
Chemist.

JOSEPH H. BOWEN,
Master Mechanic.

J. L. GREGG,
Assistant Chemist.

NELLIE BISHOP,
Stenographer.

Consultants:

WILLIAM DeGARMO TURNER, Ph. D.,
Professor of Chemistry.

CARROLL RALPH FORBES, E. M.,
Professor of Mining.

CHARLES LAURENCE DAKE, Ph. D.,
Professor of Geology.

CHARLES YANCEY CLAYTON, Met. E.,
Professor of Metallurgy.

The Mining Experiment Station was established by the Board of Curators June 1, 1909.

It is the object of the station to conduct such original researches or to verify such experiments as relate to the properties and uses of mineral products; to investigate the engineering problems connected with the mineral industry, the economic methods of mining and the preparation of mineral products, the methods of preventing waste of the mineral resources and the methods of preventing accidents in mines, mills, and smelters; to assist in improving the conditions surrounding the labor in mines, mills, and smelters; and such other researches or experiments as bear directly upon the application of mining and metallurgical engineering to the mineral industry of the State of Missouri.

The following bulletins are of recent issue:

Bibliography of Roasting, Leaching, Smelting and Electrometallurgy of Zinc, by H. L. Wheeler.

The Effect of Addition Agents in Flotation, Part II, by M. H. Thornberry and H. T. Mann.

Road Problems in the Ozarks, by E. G. Harris. Second edition, rewritten and enlarged.

The Carbonization of Missouri Cannel Coals, by H. L. Dunlap.

Coal Mining Methods in Missouri, by William Walbridge Weigel.

Any resident of the State may on request obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Correspondence regarding these bulletins or the work of the Station may be addressed to the Director, Mining Experiment Station, Rolla, Missouri.

During the past year over 1,200 samples of ores, clays, coals, water, asphaltum, limestones, etc., were identified, tested or analyzed in some manner by the staff of the Experiment Station for citizens of Missouri.

MISSOURI BUREAU OF GEOLOGY AND MINES

(MISSOURI GEOLOGICAL SURVEY)

The Missouri Bureau of Geology and Mines—or The Missouri Geological Survey, as it is more commonly known—has its headquarters at Rolla, and occupies the Rolla Building on the School campus.

BOARD OF MANAGERS

GOVERNOR ARTHUR M. HYDE, Jefferson City,
President.

ELIAS S. GATCH, St. Louis,
Vice-President.

JOHN P. CONNELL, Glencoe,
Secretary.

EDWARD M. SHEPARD, Springfield,
Chairman of Publication Committee.

PHILIP N. MOORE, St. Louis.

STATE GEOLOGIST

H. A. BUEHLER.

EQUIPMENT AND INVESTIGATIONS

The Geological Survey has at the present time a library of approximately five thousand volumes and pamphlets on geological and allied subjects, and a museum of seven thousand specimens of clay, coal, barite, lead and zinc ore, iron ore, and other mine and quarry products of Missouri.

The Geological Survey is organized principally to aid in the development of the mineral resources of Missouri. Information concerning these resources is gathered through observations in the field by members of the staff. Geologic and topographic maps are prepared of different parts of the State and the various formations are accurately described in accompanying reports. The relation of geology to the ore deposits is also worked out and detailed reports published concerning such investigations.

The Bureau, in co-operation with the United States Geological Survey, also maintains a water resource branch for the investigation of water powers and flood prevention.

The Geological Survey has the following reports available for distribution at the present time:

Preliminary Report........................Vol. XIII.
Geology of Miller County.................Vol. I., 2d series.
Quarrying Industry of Missouri...........Vol. II., 2d series.
Geology of Moniteau County.............Vol. III., 2d series.
Geology of the Granby Area..............Vol. IV., 2d series.

ADMISSION

Under the statutes, persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation.

Students are admitted in the following ways:

By Certificate.—Applicants who are graduates from accredited high schools of Missouri will be admitted without examination upon presentation of official certificates showing fifteen units of credit. Of these units, three in English, one and one-half in Algebra, one in Plane Geometry, one-half in Solid Geometry and one in Physics are required.

Certificates will be accepted from high schools in other states which are affiliated with their respective state universities, provided these are of similar rank with the University of Missouri.

Graduates of high schools who lack credit in the required units must pass an examination to make up such deficiency.

A unit is the equivalent of a subject pursued five periods a week for thirty-six weeks.

By Examination.—Applicants who are not graduates of high schools are required to pass examinations in fifteen units as outlined below, a unit being equivalent to a year's work in one subject as given in approved high schools.

By Advanced Standing.—Applicants may be admitted to advanced standing either upon examination in the subjects of the previous year or years or upon certificate from another institution of work accomplished which, in the estimation of the faculty, is equivalent to that completed here by the class into which entrance is sought. They must also before becoming candidates for degrees present evidence of the satisfactory completion of all entrance requirements into the Freshman Class. Every applicant must also present a letter of honorable dismissal from the school last attended.

As Special Students.—Mature applicants who have not the full number of entrance units may be admitted under the following provisions:

1. They must be at least twenty-one years of age.
2. They must pass such examinations or other tests as shall demonstrate their fitness to pursue profitably all the subjects selected by them.
3. They shall not be candidates for a degree.

Maximum and Minimum Number of Units in Each Subject Accepted for Entrance.

Subject.	Min.	Max.
English	3	4
Algebra	1½	2
Plane Geometry	1	1
Solid Geometry	½	½
Trigonometry	0	1
Advanced Arithmetic	0	1
Commercial Arithmetic	0	1
History	0	4
American Government	0	1
Greek	0	2
Latin	0	2
French	0	2
German	0	2
Spanish	0	2
Agriculture	0	1
Biology	0	1
Botany	0	1
Chemistry	0	2
Physics	1	2
Physiology	0	1
Zoology	0	1
Physical Geography	0	1
Commercial Geography	0	1
Bookkeeping	0	2
Drawing	0	2
Economics	0	2
Manual Training	0	2
Psychology	0	1

ACCREDITED HIGH SCHOOLS IN MISSOURI

Adrian
Albany
Anderson
Appleton City
Armstrong
Ash Grove
Aurora
Auxvasse
Ava
Barnard
Bellflower
Benton
Bolton
Bethany
Bevier
Bigelow
Billings
Bismarck
Bloomfield
Blue Springs
Bolivar
Bonne Terre
Boonville
Bosworth
Bowling Green
Braymer
Breckenridge
Brookfield
Browning
Brunswick
Bucklin
Buckner
Buffalo
Bunceton
Burlington Junction
Butler
Cabool
Cainesville
California
Callao
Cameron
Campbell
Canton
Cape Girardeau
Carl Junction
Carrollton
Carterville
Carthage
Caruthersville
Cassville
Centralia
Chaffee
Charleston
Chillicothe
Chula
Clarence
Clarksburg
Clayton
Clifton Hill
Clinton
Coffey
Cole Camp
Columbia
Concordia
Corder
Craig
Crane
Dawn
Dearborn
Deepwater
DeKalb
Desloge
DeSoto
Dexter
Dixon
Doe Run
Doniphan
Downing
Drexel
East Prairie

Edgerton
Edina
Eldon
Eldorado Springs
Ellington
Elmo
Elsberry
Elvins
Eminence
Eolia
Esther
Eureka
Everton
Excelsior Springs
Fairfax
Farmington
Fayette
Ferguson
Festus
Flat River
Forest City
Fornfelt
Forsyth
Frankford
Fredericktown
Fulton
Gallatin
Galt
Garden City
Gideon
Gilliam
Gilman City
Glasgow
Golden City
Gorin
Gower
Graham
Grain Valley
Granby
Grant City
Green City
Greenfield
Green Ridge
Greenville
Hale
Hamilton
Hannibal
Hardin
Harmony
Harrisonville
Hayti
Herculaneum
Hermann
Hickman Mills
Higbee
Higginsville
Holden
Holt
Hopkins
Houston
Humansville
Hume
Huntsville
Independence
Ironton
Jackson
Jameson
Jamesport
Jasper
Jefferson City
Joplin
Kahoka
Kansas City
  Central
  Manual Training
  Northeast
Kearney
Kennett
Keytesville
King City
Kirksville
Kirkwood
Knobnoster
Knox City
LaBelle
Laclede
Laddonia
LaGrange
Lamar
Lamonte
Lancaster
LaPlata
Lathrop
Lawson

Leadwood
Lebanon
Lees Summit
Lewistown
Lexington
Liberal
Liberty
Linneus
Lockwood
Louisiana
Macon
Madison
Maitland
Malden
Mansfield
Maplewood
Marceline
Marionville
Marshall
Marshfield
Maryville
Maysville
Meadville
Memphis
Mexico
Milan
Mindenmines
Moberly
Monett
Monroe City
Montgomery City
Morehouse
Morley
Morrisville
Mound City
Mountain Grove
Mountain View
Mt. Vernon
Neosho
Nevada
New Franklin
New Hampton
New Haven
New London
New Madrid
New Point
Norborne
Novelty
Oak Grove
Odessa
Oran
Organ
Orrick
Osceola
Otterville
Overland
Ozark
Palmyra
Paris
Parma
Pattonsburg
Peculiar
Peirce City
Perry
Perryville
Piedmont
Pineville
Platte City
Plattsburg
Pleasant Hill
Polo
Poplar Bluff
Portageville
Potosi
Princeton
Purdin
Puxico
Queen City
Ravenwood
Raymore
Raytown
Republic
Rich Hill
Richland
Richmond
Ridgeway
Rockingham
Rockport
Rocky Comfort
Rolla
St. Charles
Ste. Genevieve
St. James

St. Joseph
    Benton
    Central
St. Louis
    Central
    Cleveland
    McKinley
    Soldan
    Yeatman
Salem
Salisbury
Sarcoxie
Savannah
Sedalia
Seneca
Seymour
Shelbina
Shelbyville
Sheldon
Sheridan
Sikeston
Skidmore
Slater
Smithville
Springfield
Stanberry
Steelville
Stewartsville
Stockton
Sturgeon
Sullivan
Sweet Springs
Tarkio
Thayer
Tina
Tipton
Trenton
Triplett
Troy
Union
Union Star
Unionville
University City
Urbana
Vandalia
Versailles
Walnut Grove
Warrensburg
Warsaw
Washington
Webb City
Webster Groves
Wellington
Wellston
Wellsville
Weston
Westboro
West Plains
Williamsville
Willow Springs
Windsor
Winona
Wyaconda

ACCREDITED PRIVATE SCHOOLS.

Name.	*Address.*
Academy of Marionville College	Marionville
Academy of Rockhurst College	Kansas City
Academy of Conception College	Conception
Cathedral High School	St. Joseph
Country Day School	Kansas City
Academy of Chaminade College	Clayton
De LaSalle Academy	Kansas City
Iberia Academy	Iberia
Kemper Military School	Boonville
Kendrick Catholic Boys' High School	St. Louis
Kidder Institute	Kidder
Missouri Military Academy	Mexico
School of the Ozarks	Hollister
Rosetti-Kain High School	St. Louis
St. Vincent's High School	Perryville
Wentworth Military Academy	Lexington

FEES AND EXPENSES

Tuition Fee.—Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after January 1, 1909, non-residents of Missouri who matriculate in any department of the university be required to pay a tuition fee of $20.00 per year."

Contingent Deposits.—A deposit of $25.00 is required from each student to cover the cost of extra supplies and damage to apparatus. This deposit must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Registration Fee.—By order of the Curators, a registration fee of $10.00 a term will be charged all students.

Laboratory Fees

Chemistry.

2	General Chemistry Laboratory	$5.00
6	Qualitative Analysis	10.00
8	Gravimetric Analysis	5.00
10	Volumetric Analysis	5.00
18	Organic Analysis	10.00

For each other laboratory course in Chemistry a fee of $2.00 is charged, and in addition the student pays for special chemicals used in the particular course by charging them against his contingent deposit.

Civil Engineering.

102	Plane Surveying	$3.00
104	Topographic Surveying	3.00
107	Railroad Surveying	2.00
109	Highway Engineering	3.00

Drawing.

211	Elementary Drawing	3.00
212	Descriptive Geometry	1.50
221	Advanced Mechanical Drawing	1.00
222	Civil Engineering Drawing	1.00
223	Machine Drawing	1.00
224	Mine Drafting	1.00
251	Advanced Civil Engineering Drawing	1.00
252	Advanced Machine Drawing	1.00

253	Advanced Mápping and Topographic Drawing.	$1.00
254	Graphic Charts	1.00
1117	Oil Field Engineering Drawing	1.00

Geology and Mineralogy.

501	Crystallography	1.00
503	Mineralogy	5.00
503	Mineralogy Contingent Deposit	5.00
505	Rocks and Minerals	2.00
513	General Geology	2.00
530	Lithology	2.00
532	Petrography	3.00
534	Petrography	2.00
543	Field Geology	5.00
545	Oil and Gas	2.00
551	Paleontology	3.00
553	Paleontology	3.00
653	Materials Laboratory	2.50

Hygiene and Student Health.

62	General Zoology	2.00
64	General Botany	2.00
66	General Bacteriology	2.00

Mechanical Engineering.

701	Forge Shop	2.50
702	Pattern Shop and Foundry	2.50
703	Machine Shop and Acetylene Welding	5.00
770	Power Plants	4.00
771	Power Plants	4.00
774	Power Plant Laboratory	4.00
775	Power Plant Laboratory	4.00
776	Power Plant Laboratory	4.00
777	Power Plant Laboratory	4.00
780	Mining Machinery Laboratory	4.00

Metallurgy and Ore Dressing.

802	Fire Assaying	18.00
804	Fire Assaying	10.00
805	Introductory Metallurgy	5.00
808	General Metallurgy Laboratory	4.00
812	Non-Ferrous Metallurgy	3.00
814	Non-Ferrous Metallurgy	3.00
822	Electrometallurgy Laboratory	2.50
832	Ore Dressing Laboratory	2.00
834	Ore Dressing Laboratory	2.00
864	Alloys and Metallography	3.00
866	Alloys and Metallography	2.00

Mining.

901	Mine Surveying	$3.00
903	Mining Laboratory	2.50

Physics and Electrical Engineering.

1001	Physics Laboratory	2.00
1003	Physics Laboratory	2.00
1030	Radio Communication	2.00
1051	Dynamo Laboratory	2.00
1053	Dynamo Laboratory	2.00
1056	Electrical Machinery Laboratory	2.00
1058	Electrical Machinery Laboratory	2.00
	Gymnasium and Athletic Fee, per term	5.00
	Diploma Fee	5.00

A student who has to repeat a laboratory course will be charged a second fee for that course. For finishing an incomplete laboratory course a prorated additional fee will be charged.

Total Expenses for Fees for Four-Year Courses According to Curriculum

	Resident.	Non-resident.
Mine Engineering	$264.75	$344.75
Metallurgical Engineering	262.75	342.75
Chemical Engineering	265.25	345.25
Civil Engineering	208.25	288.25
General Science	226.75	306.75
Mechanical Engineering	221.75	301.75
Electrical Engineering	224.75	304.75

The Senior inspection trip in Mining, Metallurgical and Chemical Engineering courses costs from $75.00 to $100.00.

Room rent costs from $8.00 to $15.00 per month.

Table board at the present time will cost about $30.00 a month.

SCHOLARSHIPS AND AIDS

Scholarships.—The Sarah L. G. Wilson Scholarship, Woman's Auxiliary, American Institute of Mining and Metallurgical Engineers.

This scholarship carries a stipend of $750 per year and is to be assigned for four consecutive years to the same candidate. The successful applicant must be a candidate for either a mining or metallurgical degree, and in making the award consideration is to be given, first, to the pecuniary needs of the candidate and, second, to his scholastic standing, but no candidate shall be chosen who has not successfully passed all his first semester freshman work and who has not received a grade of S or better in at least 50 per cent of that work.

Jackling Loan Fund.—Loans may be made to students of the School of Mines from the Jackling Loan Fund. The purpose of the Jackling Loan Fund is to help worthy students who require financial assistance and who are unable to borrow money from other sources. Primarily, the fund was established to help students who are well along in their work, such as Seniors or Juniors.

The following conditions must be fulfilled:

1. The student, in order that he may become a borrower, shall have been in attendance at the School for at least one year, and if the condition of the fund warrants it, the application from such men may receive the consideration of the Executive Committee.
2. Written requests for loans must be filed with the Director and are considered by the Executive Committee of the Board of Curators.
3. No loan of more than $100 may be made to any one student during the calendar year, and not more than $25 is paid on such loans at one time.
4. The student shall give his note for the amount of the loan, said note to bear interest at the rate of five (5) per cent per annum from date to one year after the student's graduation or his leaving the school.
5. If the student finds it impossible to meet payment of his notes at maturity, he may make application for an extension of time, not to extend beyond one year after graduation or his leaving school, and the renewal notes shall bear interest at the rate of eight (8) per cent per annum from date of renewal. Accrued interest on notes to be renewed must be paid on renewal.
6. Applications for loans and notes given in settlement must be signed by parent or guardian or other acceptable responsible guarantor.

RULES AND REGULATIONS

The School Year.—The regular school year comprises two terms of approximately eighteen weeks each, so arranged that the Christmas Holiday forms the division between the fall term and the winter term. The curricula are based on the fall and winter terms, and are normally completed in four years. However, an opportunity is offered in some courses to make up deficiencies or complete prerequisites during the summer.

During the summer of 1922 a summer term of eight weeks will be held. The subjects offered will be such as to enable students to make up deficiencies and to afford opportunity for some students to complete work required for graduation. The regular summer school is discontinued for the summer of 1923.

The Normal Curriculum.—The number of credit hours required for graduation ranges from 185 to 197, dependent upon the curriculum pursued. This includes Military Science and Tactics.

The Credit Hour.—A credit hour is the credit obtained for satisfactorily passing a course of one hour in the classroom per week for one term. In computing the relation between laboratory and classroom hours, two laboratory hours are considered the equivalent of one classroom hour. This does not apply to Military Science and Tactics.

The Normal Term Schedule.—The standard schedule carries not less than sixteen and not more than twenty-two credit hours. Departure from these limits requires special permission of the Faculty.

System of Grading.—The following system of recording grades has been adopted:

E—Excellent	95 - 100%
S—Superior	85 - 95%
M—Medium	75 - 85%
I—Inferior	65 - 75%
F—Failure, below	65%

Minimum Requirement.—Any student who fails to complete satisfactorily 10 credit hours of work per term, at least five of which must be for classroom work, will be dropped from the roll of the school. Any student who falls below a grade of M in 50 per cent of the credit hours on his schedule at any time will be required to drop at least one subject.

Absences.—Any student who absents himself from any class during either of the two days immediately preceding or the two days succeeding any regular holiday or vacation period of the School of Mines shall be reported to the Student Adviser, and, unless he can offer a satisfactory explanation, the Student Adviser shall instruct the Registrar to record against him on his record card additional requirements in credit hours for graduation to the amount of not less than one, or more than six, hours for each offense.

A student shall have added to his requirements for graduation one credit hour for each total of sixteen absences during a term.

Student Health.—The student health is carefully looked after. Fifteen lectures are given on hygiene to all first-year students during the first term. A thorough physical examination is made of every student entering school and his physical exercises are directed by the Physical Director and Medical Examiner.

Conduct.—The student is expected to pursue his studies with diligence, to attend classes regularly, to live morally and maintain good behavior. The removal of those who fail to meet these requirements is in the interest of the school. Students are under the direct superivision of the school only when on the campus, but they are responsible for their conduct wherever they may be.

DEGREES

Degrees.—The following degrees are offered:

Bachelor of Science, Bachelor of Science in Mine Engineering, Bachelor of Science in Metallurgy, Bachelor of Science in Civil Engineering, Bachelor of Science in Mechanical Engineering, Bachelor of Science in Electrical Engineering and Bachelor of Science in Chemical Engineering.

Master of Science, Master of Science in Mine Engineering, Master of Science in Metallurgy, Master of Science in Civil Engineering, Master of Science in Mechanical Engineering, Master of Science in Electrical Engineering and Master of Science in Chemical Engineering.

Engineer of Mines, Metallurgical Engineer, Civil Engineer, Mechanical Engineer, Electrical Engineer and Chemical Engineer.

The Candidate for the degree of Bachelor of Science, or Bachelor of Science in an engineering curriculum, shall complete, in residence for at least the Senior year, the prescribed course of study in General Science, or in the corresponding engineering curriculum.

The Candidate for the degree of Master of Science, or Master of Science in an engineering curriculum, shall hold the degree of Bachelor of Science, or Bachelor of Science in an engineering curriculum from an institution of recognized standing, and shall complete in residence a one year's course of graduate work, approved by the faculty, and shall submit an acceptable thesis.

The Candidate for an engineering degree shall hold a degree of Bachelor or Master of Science in an engineering curriculum from this institution, and shall submit an acceptable thesis covering professional investigation within the chosen field, together with a satisfactory record of at least five years professional experience in this field, provided that if the degree of Bachelor or Master of Science has been granted in the same Department in which the engineering degree is desired, then a satisfactory record of at least three years of professional experience shall be submitted.

CURRICULA

Curricula Offered.—The School of Mines and Metallurgy offers the following curricula. The Roman numerals identify the curricula.

I. Mine Engineering.
II. Metallurgy.
III. Civil Engineering.
IV. General Science.
V. Mechanical Engineering.
VI. Electrical Engineering.
VII. Chemical Engineering.

The several courses of study are arranged to contain all the necessary fundamental sciences and language and the essential technical subjects in such order as to lead to a logical and coherent technical education. In recognition of the demand from the mineral industry and the engineering profession for specific technical training, certain definite options are offered. The mine engineering student who does not care to take the General Mining Course may specialize in (a) Coal Mining, (b) Mining Geology, (c) Petroleum Engineering. Students are strongly advised to take the General Course unless they have special qualifications or reasons for pursuing one of the options. The choice of the Coal or Petroleum Engineering Option should be made in the Sophomore year and of the Mining Geology Option in the Junior or Senior year, as is shown by the courses of study for those years. Preceding the work of the Senior year, the courses are largely fundamental, and all regular students are required to take full work in English, Physics, General Chemistry and Mathematics.

The General Science curriculum, IV, differs from the Engineering curricula in that it contains no applied science subjects, but pure science subjects only. It is directed toward giving an education either in geological science, or in chemical and physical science. The graduates from the course are fitted to pursue research work, or to enter the teaching profession in college work in physics, chemistry or geology.

Graduate Courses.—Graduate work is offered in mining, metallurgy, geology, chemistry and civil engineering. The work is elective, under the advice of the faculty.

Courses in Vocational Training. (VIII).—In co-operation with the U. S. Veterans' Bureau, courses are offered in topographic engineering, highway engineering, and oil field engineering. These courses do not lead to a degree.

Laboratory Training.—The School of Mines and Metallurgy maintains extensive laboratories for practical instruction. The school has been in existence for fifty years and has acquired, especially in geology and mineralogy, metallurgy and mining, and chemistry, excellent collections and equipment. The surroundings of the school lend themselves well to field work in geology. The Mining Department operates an experimental mine, located within a short distance from the school campus. Every effort is made thoroughly to ground the students in the fundamental sciences, and to make the technical instruction practical as well as scientific. The school keeps in close touch with the mining and metallurgical operations in the several mining districts of the state. All curricula, except that in General Science, IV, are the same in the Freshman year and differ but slightly in the Sophomore year. The student thus need not make a choice of special work until after being well started in his course.

Physical Training and Military Science and Tactics.—Military Science and Tactics and Physical Training are required of all physically fit male students in the Freshman and Sophomore years. The satisfactory completion of a year of Military Science and Tactics entitles the student to six credit hours, or twelve hours' credit in the two years. For further information on military instruction and the Reserve Officers' Training Corps, refer to the section in the catalogue on "Military Science and Tactics."

Practical Work.—Before receiving a degree in any engineering course, in addition to completing a curriculum as outlined, the student must have worked not less than eight weeks in the industry or line of work in which he is specializing. If he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some mine, mill or other industrial plant, or on any work designated by the department concerned. A regularly supervised inspection trip may be taken in place of this prescribed work, if offered by the department.

Suitable reports and satisfactory credentials are required on all the work described above. This work should be done during the summer following the Junior year, if possible.

Students in curricula I, II and VII are also required to take an inspection trip during the Senior year.

Synopses of Curricula.—The synopses of the several curricula follow. The title of the course is descriptive of the work and the **number identifies the department** in which it is given. The convention of number is as follows:

Chemistry	1 - 99
Civil Engineering	100 - 199
Drawing	200 - 299
Economics	300 - 399
English and Modern Languages	400 - 499
Geology	500 - 599
Hygiene and Student Health	60 - 75[1]
Mathematics	600 - 649
Mechanical Engineering	700 - 799
Mechanics	650 - 699[2]
Metallurgy	800 - 899
Mining	900 - 999
Physical and Electrical Engineering	1000 - 1099
Vocational Training	1100 - 1199
Military Science and Tactics	M
Physical Education	PE

[1]Represent numbers lent by Department of Chemistry.
[2]Represent numbers lent by Department of Mathematics.

ALL ENGINEERING CURRICULA.

Number.	Name of Course.	Hours per week. Lect.	Hours per week. Lab.
	FIRST YEAR.		
	First Term:		
600	Plane and Spherical Trigonometry	5	0
400	Rhetoric and Composition	3	0
211	Elementary Drawing	0	6
102	Plane Surveying	2	6
1 and 2	General Chemistry	3	6
M 1	Military Science and Tactics	2	1
PE 1 and 60	Physical Training	0	2
			25 ½
	Second Term:		
601	Analytical Geometry	5	0
401	Rhetoric and Composition	3	0
212	Descriptive Geometry	0	6
3 and 6	General Chemistry	4	6
701	Forge Shop		
	or	0	6
104	Topographic Surveying		
M 2	Military Science and Tactics	2	1
PE 2	Physical Training	0	2
	Special Lectures	1	25 ½

CURRICULUM I, MINE ENGINEERING.

Number.	Name of Course.	Hours per week. Lect.	Lab.
	SECOND YEAR.		
	First Term:		
602	Calculus	4	0
420	English	3	0
1000 and 1001	Physics	4	6
503	Mineralogy	0	6
7	Analytical Chemistry	2	0
8	Gravimetric Analysis	0	6
M 3	Military Science and Tactics	2	1
PE 3	Physical Training	0	2
			25 ½
	Second Term:		
603	Calculus	4	0
421	English	3	0
1002 and 1003	Physics	4	6
10	Volumetric Analysis	0	6
801 and 802	Assaying	2	6
M 4	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25 ½
	THIRD YEAR.		
	First Term:		
651	Theoretical Mechanics	3	0
1050 and 1051	Elements of Electrical Engineering	3	3
510	General Geology	3	0
530	Lithology	1	3
900 and 901	Mine and Railroad Surveying	3	6
903	Mining Laboratory	0	3
			20 ½
	Second Term:		
652	Mechanics of Materials	3	0
653	Materials Laboratory	0	3
512	General Geology	3	0
513	General Geology Laboratory	0	6
807	Principles of Metallurgy	3	0
904	Mining	4	0
1052 and 1053	Elements of Electrical Engineering	3	3
			22
	Summer:		
990	Work in Practice		

Students enrolled in the R. O. T. C. will replace the equivalent of 3 hours' work each term as scheduled by Military M 5 and 6.

CURRICULUM I, MINE ENGINEERING.

Number.	Name of Course.	Hours per week. Lect.	Lab.
	FOURTH YEAR.		
	First Term:		
540	Economic Geology	3	0
770	Power Plants	3	3
831 and 832	Ore Dressing	3	3
808	Metallurgy Laboratory	0	3
305	Economics	3	0
	Electives*	4½	0
			21
	Second Term:		
771	Power Plants	3	3
833 and 834	Ore Dressing	3	3
906	Mining	4	0
306	Economics	3	0
	Electives*	4½	0
			20½

*Subjects to be chosen by consultation with head of department.

Students enrolled in the R. O. T. C. will take as one subject Military M 7 and 8.

In addition to the general Mining Course as outlined the following options are offered: 1a Coal Mining; 1b Mining Geology; 1c Petroleum Engineering.

The Course of study in these options is the same as in the General Mining Course with the following exceptions:

CURRICULUM Ia, COAL MINING.

Number.	Name of Course.	Hours per week. Lect.	Lab.
	SECOND YEAR.		
	First Term:		
	Same as in I.		
	Second Term:		
	Omit Assaying 801 and 802, and take		
34	Fuel and Gas Analysis	0	3
221	Advanced Mechanical Drawing	0	6
			25
	THIRD YEAR.		
	Same as in I.		
	FOURTH YEAR.		
	First Term:		
	Omit Economic Geology 540, and Metallurgy Laboratory 808, and take		
908	Coal Mining	4	0
910	Mine and Mill Design	2	6
			21
	Second Term:		
911	Mine and Mill Design	0	6
	Electives	3	0
			22

CURRICULUM Ib, MINING GEOLOGY.

Number.	Name of Course.	Hours per week. Lect.	Lab.	
	SECOND YEAR.			
	Same as in I.			
	THIRD YEAR.			
	First Term:			
	May omit Mechanics 651 and take			
532	Petrography, or	2	9	24
551	Paleontology	0	6	20½
	Second Term:			
	Omit Mechanics 652 and 653 and take			
534	Petrography, or	2	6	22½
553	Paleontology	0	6	20½
	FOURTH YEAR.			
	First Term:			
	Omit Power Plants 770, and Metallurgy 808 and take			
543	Field Geology	0	6	
518	Stratigraphy	3	0	
				21
	Second Term:			
	Omit Power Plants 771 and take			
542	Economic Geology	3	0	
520	Structural Geology	3	0	
	Electives	3	0	20½

CURRICULUM Ic, PETROLEUM ENGINEERING.

Number.	Name of Course.	Hours per week.		
		Lect.	Lab.	
	SECOND YEAR.			
	Same as in Ib.			
	THIRD YEAR.			
	First Term:			
	Omit Mine Surveying 900 and 901 and Mining Lab. 903, and take			
21............	Organic Chemistry Lectures...............	4	0	
22............	Organic Chemistry Laboratory............	0	6	
				20
	Second Term:			
	Omit Principles of Metallurgy 807, Mining 904 and take			
23............	Organic Chemistry Lectures...............	4	0	
24............	Organic Chemistry Laboratory............	0	6	
				22
	FOURTH YEAR.			
	First Term:			
	Omit Economic Geology 540, Ore Dressing 831 and 832, Metallurgy Laboratory 808 and take			
543...........	Field Geology..........................	0	6	
518...........	Stratigraphy..........................	3	0	
544...........	Oil and Gas Geology....................	3	0	
545...........	Oil and Gas Laboratory..................	0	3	
	Electives..............................	3	0	
				21
	Second Term:			
	Omit Mining 906, Ore Dressing 833 and 834, and take			
520...........	Structural Geology......................	3	0	
920...........	Oil Production Methods..................	3	0	
	Electives..............................	7	0	20½

CURRICULUM II, METALLURGY.

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
	SECOND YEAR.		
	Same as in I.		
	THIRD YEAR.		
	First Term:		
1050 and 1051	Elements of Electrical Engineering	3	3
41 and 42	Physical Chemistry	3	6
651	Theoretical Mechanics	3	0
805	Introductory Metallurgy	1	3
	Electives*	3	0
			19
	Second Term:		
807	Principles of Metallurgy	3	0
809	Metallurgy of Iron and Steel	3	3
43 and 44	Physical Chemistry	2	6
1052 and 1053	Elements of Electrical Engineering	3	3
652	Mechanics of Materials	3	0
	Electives*	3	
			23
	Summer:		
890	Work in Practice		
	FOURTH YEAR.		
	First Term:		
811	Metallurgy of the Non-Ferrous Metals	4	0
863 and 864	Alloys and Metallography	2	6
831	Ore Dressing	3	0
305	Economics	3	0
770	Power Plant	3	3
	Electives*	3	
			22½
	Second Term:		
813	Metallurgy of the Non-Ferrous Metals	4	0
865 and 866	Alloys and Metallography	2	3
771	Power Plants	3	3
306	Economics	3	0
	Electives*	6	
			21
899	Senior Trip		

*Electives to be chosen in consultation with the Head of the Department. Students enrolled in the R. O. T. C. will replace the equivalent of 3 hours' work as scheduled by Military M 5, 6, 7 and 8.

CURRICULUM III, CIVIL ENGINEERING.

Number.	Name of Course.	Hours per week. Lect.	Lab.	
	SECOND YEAR.			
	First Term:			
602	Calculus	4	0	
420	English	3	0	
1000 and 1001	Physics	4	6	
221	Advanced Mechanical Drawing	0	6	
107	Railroad Surveying	2	6	
M 3	Military Science and Tactics	2	1	
PE 3	Physical Training	0	2	
				25 ½
	Second Term:			
603	Calculus	4	0	
421	English	3	0	
1002 and 1003	Physics	4	6	
651	Theoretical Mechanics	3	0	
222	Civil Engineering Drawing	0	6	
M 4	Military Science and Tactics	2	1	
PE 4	Physical Education	0	2	
				23 ½
	THIRD YEAR.			
	First Term:			
652	Mechanics of Materials	3	0	
653	Materials Laboratory	0	3	
111	Masonry Construction	3	3	
108	Highway Engineering	3	0	
109	Highway Engineering	0	9	
861	Metals in Engineering	2	0	
403	Engineering English	2	0	
				20 ½
	Second Term:			
112	Reinforced Concrete	3	6	
121	Stresses	3	6	
131	Hydraulics	3	3	
514	General Geology	3	0	
505	Rocks and Minerals	0	3	
				21
	Summer:			
190	Work in Practice			

*Students enrolled in the R. O. T. C. will replace the equivalent of 3 hours' work as scheduled by Military M 5 and 6.

CURRICULUM III, CIVIL ENGINEERING.

Number.	Name of Course.	Hours per week. Lect.	Lab.
	FOURTH YEAR.		
	First Term:		
122...........	Framed Structures........................	3	6
113...........	Masonry Design..........................	3	6
1050 and 1051..	Elements of Electrical Engineering.........	3	3
305...........	Economics...............................	3	0
	Electives................................	3	
			22½
	Second Term:		
129...........	Design..................................	0	9
1052 and 1053..	Electrical Engineering.....................	3	3
306...........	Economics...............................	3	0
	Electives................................	10	
			22

Students enrolled in the R. O. T. C. will replace the equivalent of three hours' work as scheduled by Military M 7 and 8.

CURRICULUM IV, GENERAL SCIENCE.

Number.	Name of Course.	Hours per week. Lect.	Lab.
	FIRST YEAR.		
	First Term:		
600	Plane and Spherical Trigonometry	5	0
400	Rhetoric and Composition	3	0
61	General Zoology	3	0
62	General Zoology	0	6
1 and 2	General Chemistry	3	6
M 1	Military Science and Tactics	2	1
PE 1 and 60	Physical Training	0	2
			23½
	Second Term:		
601	Analytical Geometry	5	0
401	Rhetoric and Composition	3	0
63	General Botany	3	0
64	General Botany	0	6
3 and 6	General Chemistry	4	6
M 2	Military Science and Tactics	2	1
PE 2	Physical Training	0	2
			26
	SECOND YEAR.		
	First Term:		
602	Calculus	4	0
	or		
460	Elementary French	5	0
420	English	3	0
1000 and 1001	Physics	4	6
503	Mineralogy	0	6
7	Analytical Chemistry	2	0
8	Gravimetric Analysis	0	6
M 3	Military Science and Tactics	2	1
PE 3	Physical Training	0	2
			25½
	Second Term:		
603	Calculus	4	0
	or		
461	Scientific French	5	0
421	English	3	0
1002 and 1003	Physics	4	6
10	Volumetric Analysis	0	6
302	Economic Geography	3	0
M 4	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			21½

CURRICULUM IV, GENERAL SCIENCE.

Number.	Name of Course.	Hours per week.	
		Lect.	Lab.
	THIRD YEAR.		
	First Term:		
41 and 42	Physical Chemistry	3	6
863 and 864	Alloys and Metallography	2	6
450	Elementary German	5	0
	Electives	6	
			22
	Electives from the following subjects:		
21	Organic Chemistry	4	0
22	Organic Chemistry	0	6
510	General Geology	3	0
530	Lithology	1	3
1010 and 1011	Electricity and Magnetism	3	3
611	Statistical Mechanics	5	0
65 and 66	Bacteriology	2	4
	Second Term:		
43 and 44	Physical Chemistry	2	6
451	Scientific German	5	0
	Electives	12	
			22
	Electives from the following subjects:		
512	General Geology	3	0
513	General Geology Laboratory	0	6
1012 and 1013	Light	3	6
609	Advanced Calculus	5	0
302	Economic Geography	3	0
23	Organic Chemistry	4	0
24	Organic Chemistry	0	6

CURRICULUM IV, GENERAL SCIENCE—Continued.

Number.	Name of Course.	Hours per week. Lect.	Lab.
	FOURTH YEAR.		
	First Term:		
305	Economics	3	0
	Thesis	0	9
	Electives	14	
			21 ½
	Electives from the following subjects:		
540	Economic Geology	3	0
501	Crystallography	3	0
551	Paleontology	0	6
532	Petrography	2	9
518	Stratigraphy	3	0
25	Organic Chemistry	3	0
45	Advanced Physical Chemistry	3	0
1014 and 1015	Heat	3	3
425	English, Contemporary Drama	3	0
	Second Term:		
306	Economics	3	0
	Thesis	0	9
	Electives	14	
			21 ½
	Electives from the following subjects:		
542	Economic Geology	3	0
520	Structural Geology	3	0
522	Geology Conference	1	0
47	Chemistry of Colloids	3	0
37	General Principles of Chemistry	3	0
425	English, Contemporary Drama	3	0
1016 and 1017	Radioactivity	3	3
534	Petrography	2	6
553	Paleontology	0	6

Students enrolled in the R. O. T. C. will replace the equivalent of 3 hours' work, as scheduled by Military M 5, 6, 7 and 8.

CURRICULUM V, MECHANICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	SECOND YEAR.		
	First Term:		
602	Calculus	4	0
420	English	3	0
1000 and 1001	Physics	4	6
221	Advanced Mechanical Drawing	0	6
702	Pattern Shop and Foundry	1	6
M 3	Military Science and Tactics	2	1
PE 3	Physical Training	0	2
			24½
	Second Term:		
603	Calculus	4	0
421	English	3	0
1002 and 1003	Physics	4	6
651	Theoretical Mechanics	3	0
223	Machine Drawing	0	3
703	Machine Shop	0	6
M 4	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25

CURRICULUM V, MECHANICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.	
	THIRD YEAR.			
	First Term:			
652	Mechanics of Materials	3	0	
653	Materials Laboratory	0	3	
1050 and 1051	Elements of Electrical Engineering	3	3	
710	Thermodynamics	3	0	
715	Machine Design	2	0	
714	Mechanisms	0	6	
774	Power Plant Laboratory	0	3	
403	Engineering English	2	0	
				20½
	Second Term:			
1052 and 1053	Elements of Electrical Engineering	3	3	
34	Fuel and Gas Analysis	0	3	
131	Hydraulics	3	3	
716	Machine Design	3	3	
713	Steam and Gas Engines	3	0	
775	Power Plant Laboratory	0	3	
726	Valve Gears	2	0	
				21½
	FOURTH YEAR.			
	First Term:			
305	Economics	3	0	
722	Advanced Machine Design	2	0	
724	Advanced Machine Design Laboratory	0	6	
776	Power Plant Laboratory	0	3	
861	Metals in Engineering	2	0	
728	Steam and Hydraulic Turbines	3	0	
730	Power Plants	3	0	
1055 and 1056	Electrical Machinery	3	3	
				22
	Second Term:			
306	Economics	3	0	
731	Power Plants	3	0	
725	Power Plant Design	2	6	
1057 and 1058	Electrical Machinery	3	3	
727	Refrigeration and Compressed Air	2	0	
777	Power Plant Laboratory	0	3	
711	Heating and Ventilating	2	0	
				21

CURRICULUM VI, ELECTRICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.	
	SECOND YEAR.			
	Same as in V.			
	THIRD YEAR.			
	First Term:			
652	Mechanics of Materials	3	0	
653	Materials Laboratory	0	3	
1050 and 1051	Elements of Electrical Engineering	3	3	
770	Power Plants	3	3	
718	Mechanisms	0	3	
41 and 42	Physical Chemistry	3	6	
715	Machine Design	2	0	
				23
	Second Term:			
1052 and 1053	Elements of Electrical Engineering	3	3	
771	Power Plants	3	3	
716	Machine Design	3	3	
43 and 44	Physical Chemistry	2	6	
1054	Electric Transmission and Distribution	3	3	
				23
	Summer:			
1090	Work in Practice			
	FOURTH YEAR.			
	First Term:			
305	Economics	3	0	
1055	Electrical Machinery	3	0	
1056	Electrical Machinery	0	3	
1059	Power Stations	3	3	
861	Metals in Engineering	2	0	
724	Advanced Machine Design	0	6	
	Electives	5		
				22
	Second Term:			
306	Economics	3	0	
1057	Electrical Machinery	3	0	
1058	Electrical Machinery	0	3	
1060	Electric Railways	3	3	
1096	Thesis and Design	0	12	
	Electives	5		
				23

CURRICULUM VII, CHEMICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	SECOND YEAR.		
	First Term:		
602	Calculus	4	0
420	English	3	0
1000 and 1001	Physics	4	6
503	Mineralogy	0	6
7	Analytical Chemistry	2	0
8	Gravimetric Analysis	0	6
M 3	Military Science and Tactics	2	1
PE 3	Physical Training	0	2
			25½
	Second Term:		
603	Calculus	4	0
421	English	3	0
1002 and 1003	Physics	4	6
10	Volumetric Analysis	0	6
31 and 32	Inorganic Chemistry	2	6
M 4	Military Science and Tactics	2	1
PE 4	Physical Training	0	2
			25½
	THIRD YEAR.		
	First Term:		
651	Theoretical Mechanics	3	0
1050 and 1051	Elements of Electrical Engineering	3	3
41 and 42	Physical Chemistry	3	6
21	Organic Chemistry	4	0
22	Organic Chemistry Laboratory	0	6
			20½
	Second Term:		
652	Mechanics of Materials	3	0
653	Materials Laboratory	0	3
1052 and 1053	Elements of Electrical Engineering	3	3
43 and 44	Physical Chemistry	2	6
23	Organic Chemistry	4	0
24	Organic Chemistry Laboratory	0	6
			21
	Summer:		
90	Work in Practice		

Students enrolled in the R. O. T. C. will replace the equivalent of 3 hours' work as scheduled by Military M 3.

CURRICULUM VII, CHEMICAL ENGINEERING

Number.	Name of Course.	Hours per week. Lect.	Lab.
	FOURTH YEAR.		
	First Term:		
305	Economics	3	0
450	Elementary German	5	0
770	Power Plant	3	3
51 and 52	Industrial Chemistry	3	6
	Electives*	3	
			21½
	Second Term:		
306	Economics	3	0
451	Scientific German	5	0
771	Power Plant	3	3
53 and 54	Industrial Chemistry	3	6
99	Senior Trip		
	Electives*	3	
			21½

*Subject to be chosen by consultation with head of department. Students in R. O. T. C. will take as one subject Military M 4.

DEPARTMENTS OF INSTRUCTION

In the following statement of courses, the departments of instruction are arranged alphabetically.

The number of each course identifies the department in which it is given, the numbers being apportioned to the several departments as follows:

Chemistry	1 - 99
Civil Engineering	100 - 199
Drawing	200 - 299
Economics	300 - 399
English and Modern Languages	400 - 499
Geology	500 - 599
Hygiene	60 - 75[1]
Mathematics	600 - 649
Mechanical Engineering	700 - 799
Mechanics	650 - 699[2]
Metallurgy	800 - 899
Mining	900 - 999
Physics and Electrical Engineering	1000 - 1099
Vocational Training, U. S. Veterans' Bureau	1100 - 1199
Military Science and Tactics	M
Physical Education	PE

In the description of each course are stated the curricula in which the course is required. All courses cover an entire term of approximately eighteen weeks. Numbers in parentheses designate the courses which the student must have completed as prerequisite to his admission to the course described.

No student is admitted to any course unless he has fulfilled all the requirements for that course as stated in the Catalogue, or has otherwise satisfied the instructor that he is prepared to pursue it.

[1]Represents numbers lent by Department of Chemistry.
[2]Represents numbers lent by Department of Mathematics.

CHEMISTRY

PROFESSOR TURNER, ASSOCIATE PROFESSOR DUNLAP, ASSISTANT PROFESSOR KERSHNER, ASSISTANT PROFESSOR MONROE, MR. NUDELMAN, MR. LANE, MR. REMBERT, MR. TAYLOR.

EQUIPMENT.

One entire building is devoted to chemistry. The laboratories for general chemistry, on the first floor of the main building, accommodate together one hundred ninety-two students. The quantitative laboratories on the second floor have desk room for one hundred twenty students. The north wing contains a lecture room and a capacious laboratory for industrial chemistry with a small auxiliary industrial research laboratory.

In the south wing are a large lecture room seating one hundred fifty and a small class room, while in the basement are laboratories for physical, organic and theoretical chemistry accommodating twenty to forty students each, together with a lecture room with a seating capacity of forty-eight.

The equipment includes one hundred ninety-two outfits for freshmen chemistry and qualitative analysis; one hundred twenty outfits for gravimetric and volumetric analysis (including excellent analytical weights, platinum crucibles and standardized burettes); thirty-two outfits for physical chemistry together with an adequate selection of precision instruments and accessories; thirty outfits for organic chemistry; and ample replacement stock.

The machines installed in the industrial laboratory include mixing and grinding machines, filter presses, centrifuges, apparatus for distillation and rectification of liquids, apparatus for dry distillation of woods, etc., caustic pot, nitrator, sulphanator, fusion kettle, autoclave, glass enameled, non-corrosive and standard kettles, drying ovens, mixing and storing tanks, and the incidentals necessary for the preparation of commercial chemicals, soaps, paints, wood products, pharmaceuticals, oils, etc.

The department has secured the co-operation of some of the chemical manufacturing concerns and has prepared for exhibition a Museum of Industrial Chemistry. Exhibits of the raw material and products illustrating the processes in many of the industries are displayed.

COURSES.

The courses in the Department of Chemistry are arranged as nearly as practicable in a logical sequence. Students in all curricula register in the Freshman year for general and qualitative chemistry, courses 1 to 6. Students in Mining, Metallurgy and Chemistry continue in the Sophomore year with analytical chemistry, courses 7 to 10, those in chemistry taking also in the second term inorganic chemistry 31 and 32.

Students in Chemistry and Metallurgy continue in the Junior year with physical chemistry, 41-44, those in chemistry registering also for organic chemistry, 21-24.

Students in Chemistry continue in the Senior year with industrial chemistry, 51-54, and may elect also an advanced course in any one of the preferred branches.

Graduate students may find electives in Analytical Chemistry (12-18), Organic Chemistry (25-29), General Principles of Chemistry (35-39), Physical Chemistry (45-49), Industrial Chemistry (55-59), Biological Chemistry (65-69), Thesis and inspection (90-99).

Numbering Convention:

1- 6 Elementary.	41-49 Physical.
7-19 Analytical.	51-59 Industrial.
21-29 Organic.	60-69 Biological.
31-39 Inorganic.	90-99 Thesis.

1. GENERAL CHEMISTRY. *Lectures.*
Freshman year, first term, 16 weeks, three hours per week.
All curricula (entrance requirements).
Text: Alexander Smith, *General Chemistry for Colleges, Mimeograph Questions.*
Assistant Professor Kershner.

A comprehensive study of the general principles of chemistry and of the more important non-metals. The fundamental laws of chemistry are developed in logical order, special attention being given to their application in practical computations. Carefully designed lecture experiments are a feature of the course. The class is divided into several smaller sections for recitation and discussion of problems.

2. GENERAL CHEMISTRY. *Laboratory.*
Freshman year, first term, six laboratory hours per week.
All curricula (Must be accompanied by 1).
Text: *Mimeograph Notes.*
Alexander Smith, *Laboratory Outline of General Chemistry.*
Assistant Professor Kershner, Mr. Rembert and Mr. Keeling.

The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

3. GENERAL CHEMISTRY. *Lectures.*

Freshman year, second term, four hours per week.
All curricula (1 and 2).
Text: Same as in 1.

Assistant Professor Kershner.

Continuation of course 1; devoted to the chemistry of the metals, with special consideration of the reactions employed in analytical chemistry. The ionic theory, mass laws, etc., are introduced and applied at advantageous points in the lectures.

6. QUALITATIVE ANALYSIS. *Laboratory.*

Freshman year, second term, six laboratory hours per week.
All curricula (1 and 2).
Text: Same as in 2 and Mimeograph Notes.
A. A. Noyes, *Qualitative Chemical Analysis.*

Assistant Professor Kershner, Mr. Rembert, and Mr. Keeling.

This course is to accompany the study of the metals in general chemistry and is devoted to the qualitative separation and detection of the metals.

7. ANALYTICAL CHEMISTRY. *Lectures.*

Sophomore year, first term, two hours per week.
Curricula I, II, IV, VII (3 and 6 to be accompanied by 8).
Text: Smith, *Quantitative Analysis.*
Manuscript Notes.

Mr. Nudelman.

The first few periods will be devoted to a discussion of the theory underlying analytical methods. During the remainder of this course the following subjects will be discussed: The balance, weights, and the process of weighing; the gravimetric operations; typical gravimetric analyses; volumetric instruments, their calibration and use; standard solutions; indicators; and typical volumetric analyses.

Problems in the calculations of analytical chemistry are a feature of the course.

8. GRAVIMETRIC ANALYSIS. *Laboratory.*

Sophomore year, first term, six laboratory hours per week.
Curricula I, II, IV, VII (to be accompanied by 7).
Text: Smith, *Quantitative Analysis.*
Manuscript Notes.

Mr. Nudelman, Mr. Taylor.

The applications of the principles of quantitative analysis as illustrated in the simpler gravimetric determinations.

10. VOLUMETRIC ANALYSIS. *Laboratory.*

Sophomore year, second term, six laboratory hours per week.
Curricula I, II, IV, VII (8).
Text: Same as in 8.

Mr. Nudelman, Mr. Taylor.

A study of the standard elementary volumetric methods together with technical metallurgical methods.

Actual ores, analyzed by the instructing staff, are on hand in quantity, and the students are trained to attain the degree of accuracy which obtains in analytical laboratories.

12. INDUSTRIAL ANALYSIS. *Laboratory.*

Elective, six laboratory hours per week. (12 and 22.)
Text: *Mimeograph Sheets.*

Mr. Nudelman.

General methods in industrial analysis. The course is designed to illustrate principles and to develop ability in selecting and adapting the methods of standard reference works.

14. MINERAL ANALYSIS. *Laboratory.*

Elective, six laboratory hours per week. (10.)

Mr. Nudelman.

This course is offered primarily for students who desire to become acquainted with the methods of analysis of matters, speisses, rocks, ores, etc. No required schedule is laid out.

16. WATER ANALYSIS. *Laboratory.*

Elective, six laboratory hours per week. (10.)

Mr. Nudelman.

This course is designed to meet the wants of engineering students. Industrial and sanitary water analysis are offered, although students interested in geology may substitute mineral water analysis for some of the work.

18. ORGANIC ANALYSIS. *Laboratory.*

Elective, six laboratory hours per week. (10 and 22.)

Associate Professor Dunlap.

A laboratory course in the elementary methods of organic analysis.

21. ORGANIC CHEMISTRY ALIPHATIC. *Lectures.*

Junior year, first term, four hours per week.
Curriculum VII (7).
Text: Cohen, *Theoretical Organic Chemistry.*

Associate Professor Dunlap.

This course is an introduction to the simple organic compounds. Special emphasis is placed on the structure and nomenclature of the aliphatic series.

22. ORGANIC CHEMISTRY. *Laboratory.*

Junior year, first term, six laboratory hours per week.
Curriculum VII (must be accompanied by 21).
Text: Cohen, *Practical Organic Chemistry.*

Associate Professor Dunlap.

Preparation and purification of typical aliphatic compounds, illustrating general methods of synthesis and technique of manipulations.

23. ORGANIC CHEMISTRY AROMATIC. *Lectures.*

Junior year, second term, four hours per week.
Curriculum VII (21).

Associate Professor Dunlap.

A continuation of 21, extending the consideration to aromatic compounds.

24. ORGANIC CHEMISTRY. *Laboratory.*

Junior year, second term, six laboratory hours per week.
Curriculum VII (must be accompanied by 23).
Text: As in 22.

Associate Professor Dunlap.

A continuation of 22, illustrating important synthetic processes for typical aromatic compounds, together with a study of the conditions of reactions.

25. ORGANIC CHEMISTRY HETEROCYCLIC. *Lectures.*

Graduate, first term, three hours per week.
Elective in VII (23).
Text: As in 21.

Associate Professor Dunlap.

A study of amino acids, uric acid, terpenes and some of the more complex aliphatic and aromatic compounds.

26. ADVANCED ORGANIC CHEMISTRY. *Laboratory.*

Graduate, six laboratory hours per week. (24.)
Elective in VII.

Associate Professor Dunlap.

Advanced preparations followed by intensive study of problems adapted to the special needs and ability of the students.

27. ORGANIC CHEMISTRY ADVANCED. *Lectures.*

Graduate, second term, three hours per week.
Elective in VII. (25.)
Text: *Library references.*

Associate Professor Dunlap.

A study of special organic topics.

28. ORGANIC PROCESSES. *Laboratory.*

Graduate, six laboratory hours per week. (26.)
Elective in VII.

Associate Professor Dunlap.

Students are assigned special problems according to their training and preferences.

31. INORGANIC CHEMISTRY. *Lectures.*

Sophomore year, second term, two hours per week.
Curriculum VII (7).
Text: *Library References.*

Mr. Nudelman.

A discussion of the principles of modern inorganic chemical industry.

32. INORGANIC CHEMISTRY. *Laboratory.*

Sophomore year, second term, six laboratory hours per week.
Curriculum VII (8).
Text: *Mimeograph Notes.*

Mr. Nudelman.

Preparation and purification of typical inorganic compounds illustrating modern industrial practice.

34. FUEL AND GAS ANALYSIS. *Laboratory.*

Sophomore year, second term, three laboratory hours per week.
Curricula V and VI (6).
Text: Gill, *Engine Room Chemistry.*

Mr. Nudelman, Mr. Taylor.

A practical course in fuel and gas testing adapted to the needs of engineering students.

35. GENERAL PRINCIPLES OF CHEMISTRY. *Lectures.*

Graduate, first term, three hours per week.
Elective in VII (43 and 53).
Text: Noyes & Sherrill, *General Principles of Chemistry.*

Mr. Nudelman.

A course designed to correlate the prerequisite inorganic, analytical, organic, physical and industrial courses and to give training in the application of the general principles of chemistry through the solution of various problems.

37. GENERAL PRINCIPLES OF CHEMISTRY. *Lectures.*

Graduate, second term, three hours per week.
Elective in VII (35).
Text: As in 35.

Mr. Nudelman.

A continuation of 35.

39. THE HISTORY OF CHEMISTRY. *Lectures.*

Graduate, first term, three hours per week.
Elective in VII (23 and 43).
Text: *Library References.*

Professor Turner.

A study of the development of American theory and practice (offered alternately with Chem 55).

41. PHYSICAL CHEMISTRY. *Lectures.*

Junior year, first term, three hours per week.
Curricula II, IV, VI and VII (7; to be accompanied by 42).
Text: Millard, *Physical Chemistry for Colleges.*
Manuscript Notes.

Assistant Professor Monroe.

This course comprises an introductory study of the physical properties of gases, liquids, and dilute solutions, including ionization and thermochemistry.

42. PHYSICAL CHEMISTRY. *Laboratory.*

Junior year, first term, six laboratory hours per week.
Curricula II, IV, VI and VII (Same as 41).
Text: Findlay, *Practical Physical Chemistry.*

Assistant Professor Monroe.

Laboratory to accompany 41.

43. PHYSICAL CHEMISTRY. *Lectures.*

Junior year, second term, two hours per week.
Curricula II, IV, VI and VII (41).
Text: Same as in 41.

Assistant Professor Monroe.

A continuation of 41, introducing a discussion of electrolysis, polarization, conductance, transference, overvoltage, electromotive force, atomic structure, speed of reactions, and phase law.

44. PHYSICAL CHEMISTRY. *Laboratory.*

Junior year, second term, six laboratory hours per week.
Curricula II, IV, VI and VII (must be accompanied by 43).
Text: Findlay, *Practical Physical Chemistry.*
Library References.

Assistant Professor Monroe.

Laboratory to accompany 43.

45. ADVANCED PHYSICAL CHEMISTRY. *Lectures.*

Graduate, first term, three hours per week.
Elective (43).
Text: *Library References.*

Assistant Professor Monroe.

A discussion of physico-chemical topics such as: phase rule, osmosis, hydrolysis, periodic law, radio activity, theory of indicators.

47. THE CHEMISTRY OF COLLOIDS. *Lectures.*

Graduate year, second term, three hours per week.
Elective (43).
Text: Zsigmondy, *Colloids.*

Assistant Professor Monroe.

A review of the development of the theory of colloids, together with laboratory demonstrations, to illustrate the modern practice in the study of the subject. (Offered alternately with 49.)

49. ELECTRO-CHEMICAL THEORY. *Lectures.*

Graduate, second term, three hours per week.
Elective in VII (43).
Text: LeBlanc, *Electro-Chemistry* and *References.*

Assistant Professor Monroe.

A discussion of electro-chemical reactions, theoretical, and applied in commercial operations.

(Offered alternately with 47.)

51. INDUSTRIAL CHEMISTRY. *Lectures.*

Senior year, first term, three hours per week.
Curriculum VII (23. Must be accompanied by 52).
Text: Rogers, *Manual of Industrial Chemistry.*
Kremenn-Potts, *Applications of Physico-Chemical Theory.*
Manuscript Notes.
Library References.

Professor Turner.

A survey of the classification of industrial chemical literature followed by a study of the types of plant and apparatus used in chemical operations.

52. INDUSTRIAL CHEMISTRY GENERAL PROCESSES. *Plant.*

Senior year, first term, six laboratory hours per week.
Curriculum VII (24. Must be accompanied by 51).
Text: Rogers, *Laboratory Guide of Industrial Chemistry.*
Manuscript Notes and Blue Prints.
Reference Works.

Professor Turner.

This course accompanies the lectures in General Industrial Chemistry, training the student to adapt his knowledge to large-scale operations through the actual manipulation of the apparatus studied in the classroom.

53. INDUSTRIAL CHEMISTRY, APPLIED. *Lectures.*

Senior year, second term, three hours per week.
Curriculum VII (51).
Text: *Library References.*
Manuscript Notes and Blue Prints.

Professor Turner.

A study of general chemical industries.

54. INDUSTRIAL CHEMISTRY, APPLIED. *Plant.*

Senior year, second term, six laboratory hours per week.
Curriculum VII (52 to be accompanied by 53).
Text and References: As above.

Professor Turner.

The industrial preparation of typical products.

55. INDUSTRIAL CHEMISTRY, ORGANIC. *Lectures.*

Graduate, first term, three hours per week.
Elective in VII (53, may be accompanied by 56).
Text and References: As in 53.

Professor Turner.

A study of specific organic chemical industries.
(Offered alternately with 39.)

56. INDUSTRIAL CHEMISTRY, ORGANIC. *Plant.*

Graduate, first term, six laboratory hours per week.
Elective in VII (54, may be accompanied by 55).
Text and References: As above.

Professor Dunlap.

The industrial preparation of typical organic products.

57. CHEMICAL INDUSTRIES. *Lectures.*

Graduate, second term, three hours per week.
Elective in VII (51).
Reference: Escales, *Chemie Industrielle.*

Professor Turner.

The applications of economic principles in the chemical industries. (Offered alternately with 59.)

58. CHEMICAL ENGINEERING DATA. *Library.*

Graduate, second term, three hours per week.
Elective in VII (52).

Professor Turner.

A course to supplement the work described in 57, consisting mainly of the collection and interpretation of data on the administrative as well as the scientific side of Chemical Manufacturing.

59. CHEMICAL INDUSTRIES. *Lectures.*

Graduate, second term, three hours per week.
Elective in VII (51).
Text: *Library References.*

Professor Turner.

This course is similar to 57 except that different specific industries are studied.

60-69. BIOLOGY.

See Department of Hygiene and Student Health.

90. WORK IN PRACTICE.

Summer vacation following the Junior year.
Required in Curriculum VII.

To receive a degree in Chemical Engineering, the student (a) must have worked not less than twelve weeks in some chemical plant; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some chemical plant designated by the head of the department; or (c) a regularly supervised inspection trip may be taken in place of this practice work or observation, provided such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

96. THESIS.

Either or both terms, at least six laboratory hours per week. Elective (43, 51 or 64).

Professor Turner, Associate Professor Dunlap, Assistant Professor Kershner, Assistant Professor Monroe.

Senior and graduate students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to specifications which will be sent on request.

99. SENIOR TRIP.

Senior year, second term.

Required in Curriculum VII.

During the second term of the senior year a two weeks' trip is taken either to St. Louis and vicinity or to Chicago and vicinity, for the purpose of studying chemical engineering plants and methods in these districts.

CIVIL ENGINEERING

Professor Harris, Associate Professor Armsby,
Mr. Butler, Mr. MacCarthy.

The plan of study is designed to afford training such that the graduates will be prepared to perform at once the minor duties in the various branches of the profession. Especial stress is laid upon proficiency in field work, drafting, and the design and inspection of the more common engineering structures.

For field work the department is equipped with twenty-four transits, five of which are complete mining instruments with side and top telescopes; and twenty-one wye and dumpy levels, representing the principal makes and types of construction. Additional equipment includes a solar compass, a surveyor's compass, three geologist's compasses, four Brunten transits, twenty plane-tables, two sextants, and a liberal supply of hand levels, barometers, clinometers, dip-needles, angle prisms, chains, tapes, level rods, stadia rods, range poles, etc.

The field work is so outlined that the student has an opportunity to judge the relative merits of the various types of field instruments.

An important feature of the instrument room is the locker system. Due to the scope of the equipment it has been possible to arrange in separate lockers complete equipment for each surveying squad.

The department has at its disposal three well-equipped drafting rooms.

The cement testing laboratory is equipped for making complete physical tests of cement, concrete, and concrete aggregates, and for investigations into the proper proportioning of concrete. The equipment consists of two standard tension testing machines, two Vicat apparatus, several specific gravity apparatus, one electric drying oven, one standard steamer, an autoclave, a moist closet, apparatus for the determination of specific gravity of, and voids in, concrete aggregates, several sets of standard sieves, standard cylindrical molds for concrete, and an ample supply of standard tension briquette molds, graduates, trowels, spatulas, and other small apparatus.

The laboratory for testing materials is equipped with one 200,000-pound capacity universal testing machine of the Olsen type, which is capable of testing specimens eight feet long in either tension or compression, and specimens in cross bending 16 feet

long between supports. It also contains two machines, each of 50,000-pound capacity, of the Riehle type, which are used for testing small specimens in tension, compression and cross-bending; one 60,000 inch-pound capacity torsion machine of the Olsen type, and one machine used for demonstration of the action of levers, and for testing small specimen in cross bending. All machines in this laboratory are direct connected motor-driven. The necessary small equipment, such as extensometers, compressometers, etc., is ample for the needs of the classes, and comprises only the most modern types of instruments.

This laboratory affords facilities for: Research in the design and the methods of failure of structures, the study of the physical characteristics and composition of materials, and the determination of the laws controlling materials under stress.

COURSES.

102. PLANE SURVEYING. *Lectures and Laboratory.*

Freshman year, first term, two lectures and six hours laboratory per week.

All engineering curricula (must be preceded or accompanied by course 600).

Texts: Plane Surveying by Tracy.

Mr. MacCarthy.

The theory and practice of plane surveying, including the adjustments and uses of transits, levels, and minor instruments; land surveying; traversing; leveling; determination of meridian; mapping, and the usual computations used in connection with plane surveying. The notes taken in the field are used for computation and mapping, helping to emphasize the practical nature of the work done, as well as affording a check on the field work.

The simpler problems are conducted on and about the campus, the work being referenced to stations of a triangulation system, the bearings and lengths of sides of which have been accurately determined, thus affording checks on the accuracy of the student work.

104. TOPOGRAPHIC SURVEYING. *Laboratory.*

Freshman year, second term, six hours per week.

Curriculum III; optional in some other curricula (102).

Text: Plane Surveying by Tracy.

Mr. MacCarthy.

A continuation of the work given in course 102, with the addition of some of the simpler astronomical observations, base line measurements, triangulation, stadia and plane table work, road traversing, and other problems. A complete topographical map of a small area is made.

107. RAILROAD SURVEYING. *Lectures and Laboratory.*

Sophomore year, first term, two lectures and six hours laboratory per week.

Curriculum III (104).

Text: Searles & Ives, *Field Engineering.*

Mr. Butler.

A study of the theory of simple, compound, and reverse curves; frogs and switches; turnouts and cross-overs; and earthwork. The laboratory periods are devoted to the solution of typical problems, and are conducted in the field so far as the weather permits.

108. HIGHWAY ENGINEERING. *Lectures.*

Junior year, first term, three lectures per week.

Curriculum III (107).

Text: Blanchard & Drowne, Highway Engineering.

Mr. MacCarthy.

This course treats of the economic properties of road materials, the location, construction and maintenance of roads and streets, types of improvement, their designs and estimates of cost.

109. HIGHWAY ENGINEERING. *Laboratory.*

Junior year, first term, nine hours laboratory per week.

CurriculumIII (107; to be accompanied by 108).

Mr. MacCarthy.

Designed to prepare the student for positions of minor responsibilities in highway engineering. It treats of the character and types of common roads and pavements; the types of minor highway structures; the testing of materials for highway construction; and the study of approved plans, specifications and estimates. A complete relocation of an existing highway is made, and from this plans are prepared and an estimate of cost outlined.

110. HIGHWAY ENGINEERING. *Special Credits.*

Credit given in lieu of 109 for acceptable work in practice.

111. MASONRY CONSTRUCTION. *Lectures and Laboratory.*

Junior year, first term, three lectures and three hours laboratory per week.

Curriculum III (must be preceded or accompanied by 605 and 606).

Text: Baker, *A Treatise on Masonry Construction.*

Mr. Butler.

A study of the fundamental principles underlying the selection, testing, preparation, and use of the various building materials in masonry structures. The treatment of ordinary and pile foundations, foundations under water, dams, retaining walls, piers, abutments, and culverts are successively studied.

The laboratory time is devoted chiefly to the testing of cement, concrete, and materials used in making concrete.

112. REINFORCED CONCRETE. *Lectures and Laboratory.*

Junior year, second term, three lectures and six hours laboratory per week.

Curriculum III (111, 605 and 606).

Text: Turneaure & Maurer, *Principles of Reinforced Concrete Construction.*

Mr. Butler.

The theory and design of reinforced concrete beams, slabs, tanks, dams, culverts, conduits, retaining walls, and columns.

113. MASONRY DESIGN. *Lectures and Laboratory.*

Senior year, first term, three lectures and six hours laboratory per week.

Curriculum III (112).

Texts: Baker, *A Treatise on Masonry Construction.*
Turneaure & Maurer, *Principles of Reinforced Concrete Construction.*
Wegmann, *High Masonry Dams.*

Professor Harris.

A continuation of courses 111 and 112. Includes the analysis and design of high masonry dams, reinforced concrete dams, long-span arches, concrete standpipes, reservoirs, and the like.

121. STRESSES. *Lectures and Laboratory.*

Junior year, second term, three lectures and six hours laboratory per week.

Curriculum III (605 and 606).

Text: Johnson, Bryan & Turneaure, *Modern Framed Structures*, Vols. I and III.

Mr. Butler.

Graphic and analytic determination of stresses in the simpler engineering structures, such as derricks, roof trusses, single span bridges, cantilever bridges and three hinged braced arches, under their various loads. Some time is spent on the fundamentals of structural design.

122. FRAMED STRUCTURES. *Lecture and Laboratory.*

Senior year, first term, three lectures and six hours laboratory per week.

Curriculum III (121).

Text: Same as in 121.

Mr. Butler.

A continuation of course 121, covering the complete detailed design, with estimates and bills of materials, of plate girders, bridges, roof trusses, towers, steel building frames and the like.

129. DESIGNING. *Laboratory.*

Senior year, second term, nine hours per week.
Curriculum III (113 and 122).

Professor Harris.

The work in this course is selected to accord with the line of work in which the student expects or desires to specialize. He is required to find his material in the library, and to inform himself as to the best current practice relative to the problem assigned. Throughout the term the student is required to keep informed as to the current Civil Engineering literature.

131. HYDRAULICS. *Lectures and Laboratory.*

Junior year, second term, three lectures and three hours laboratory per week.
Curricula III, V (652 and 653).
Text: Merriman, *Elements of Hydraulics.*

Professor Harris.

The theory of hydrostatics and hydraulics, and its application to the dependent problems in engineering practice; determination of empirical coefficients and their application in determining the flow of water through orifices, weirs, pipes, canals, and rivers.

132. WATER SUPPLY. *Lectures.*

Senior year, first term, three lectures per week.
Elective Curriculum III (112 and 131).
Text: Turneaure & Russell, *Public Water Supplies.*

Professor Harris.

Selection, storing, transporting, purification, and delivery of water to cities and towns.

133. SEWERAGE, DRAINAGE, AND IRRIGATION. *Lectures.*

Senior year, second term, five lectures per week.
Elective in Curriculum III (131).
Texts: Folwell, *Sewage of Cities.*
Elliott, *Land Drainage.*
Wilson, *Irrigation.*

Professor Harris.

These subjects, having much in common, are grouped together to avoid duplication and repetition. The course includes textbook work, lectures, and research by the student in the library. It is usual to include in course 129 some structure the design of which would require information derived from this course.

134. HYDRAULIC POWER, MOTORS, PUMPS, AND FANS. *Lectures.*

Senior year, second term, two lectures per week.
Elective in Curriculum III (31).
Texts: Mead, *Water Power.*
Dougherty, *Hydraulic Motors and Pumps.*
Harris, *Compressed Air.*

Professor Harris.

A continuation of course 131. Includes the theory of hydraulic motors and centrifugal pumps and fans; the various problems of water power development on rivers; and the economic effect of water storage on water power and the control of floods.

141. RAILROAD ECONOMICS. *Lectures.*

Senior year, second term, two lectures per week.
Elective in Curriculum III (107).
Texts: Williams, *Design of Railroad Location.*
Webb, *Railroad Construction.*
Current Engineering Literature.

Mr. MacCarthy.

The economic principles involved in the location, revision, operation, and financing of railroads. The work covers train resistances under varying conditions of traffic, grade, and curvature; locomotive performance; valuation of railroad properties; grade separation, etc.

190. WORK IN PRACTICE.

Summer vacation following the Junior year.
Required in Curriculum III.

To receive a degree in Civil Engineering, the student (a) must have worked not less than twelve weeks in some industry or project related to civil engineering; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching at some engineering project or industry designated by the head of the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

196. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Elective.

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to specifications which will be sent on request.

DRAWING

Associate Professor Mann.

The south side of the third floor of Norwood Hall is given over to the work in engineering drawing. This space includes three drafting rooms, an office, and a blue printing room.

The drafting rooms are equipped with seventy-five double and thirty-two single drawing desks which are arranged to accommodate the individual drawing boards, T-squares, and instruments of each student in drawing. In addition, lockers are available for fifty-four students.

The blue printing room is equipped with a Pease vertical electric printing machine; a Pease wall print washer; a large frame, for sun printing, which is mounted on a rolling carriage; a convenient paper-cutting table; and small printing frames and other miscellaneous equipment.

The aims of the general courses in drawing are so to train the student in the execution of lettering, line and detail drawing, that he will acquire habits of neatness and accuracy, system in his work, knowledge of the proper decorum in a large drafting room, and the ability to produce neat, accurate, and creditable drawings in the minimum of time consistent with good work. He is thoroughly drilled in the fundamental principles of projection as applied to engineering drawing, and is taught how to make blue prints, and something of the various other commercial methods of reproducing drawings. The more advanced courses aim to provide the student with drafting technique and drawing problems peculiar to the several specialized branches of engineering and general science.

211. ELEMENTARY DRAWING. *Laboratory.*

Freshman year, either term, six laboratory hours per week.
Curricula I, II, III, V, VI, VII.
Text: French, *Engineering Drawing.*

Associate Professor Mann.

Designed to give the student a practical working knowledge of correct methods in line and figure drawing with drawing instruments, and in the analysis and execution of standard engineering style of freehand single-stroke lettering. The fundamental principles of orthographic, isometric, oblique, and cabinet projection are covered. Practice is given in lettering, line and figure drawing, simple machine sketching, dimensioning, tracing and blue printing.

212. DESCRIPTIVE GEOMETRY. *Laboratory.*

Freshman year, second term, six laboratory hours per week.
Curricula I, II, III, V, VI, VII (211).
Text: Higbee, *Essentials of Descriptive Geometry.*
Associate Professor Mann.

Orthographic projection of points, lines, planes, curves, curved surfaces and solids in the four angles of projection; intersections and developments; and linear perspective. Many geometric problems and exercises of practical application to engineering are given the student to work out, together with a series of plates.

221. ADVANCED MECHANICAL DRAWING. *Laboratory.*

Sophomore year, first term, six laboratory hours per week.
Curricula III, V, VI (211, 212).
Text: Reid and Reid, *Mechanical Drawing and Machine Design.*
Associate Professor Mann.

Aims to familiarize the student with modern drafting room practice, drafting technique and conventions peculiar to mechanical electrical and structural engineering design; and to prepare him for the advanced work of design in his chosen field. Appropriate exercises in drawing are given.

222. CIVIL ENGINEERING DRAWING. *Laboratory.*

Sophomore year, second term, six laboratory hours per week.
Curricula I (Coal Mining Elective), and III (211, 212 and 221).
Text: French, *Engineering Drawing.*
Ketchum, *Structural Engineers Handbook.*
Department Notes.
Associate Professor Mann.

Meets certain special needs of civil and mining engineering students, such as freehand lettering for titles and maps; selection of titles of plain but good form; plotting and mapping methods; topographic conventions and symbols; the technique of drafting as applied to structural, bridge, highway, and concrete design; maps for mines; and the drawing and tracing of standard types of engineering structures and structural parts.

223. MACHINE DRAWING. *Laboratory.*

Sophomore year, second term, three laboratory hours per week.

Curricula V and VI (211, 212, 221).

Texts: Reid and Reid, *Mechanical Drawing and Machine Design.*

Departmental Notes and References.

Associate Professor Mann.

A specialized continuation of 221, in which the empirical design and drawing of simple machines and machine parts is taken up. Detailed and assembly drawings of machines are made.

224. MINE DRAFTING. *Laboratory.*

Sophomore, Junior, or Senior year. Second term (or first term for a class of not less than ten), 18 weeks, two laboratory periods of three hours each per week.

Elective in I, II.

Text: *Department Notes*, supplemented by use of Ketchum's *Design of Mine Structures* as reference.

Associate Professor Mann.

Arranged to give the students in mine engineering and metallurgy specialized knowledge and practice in drafting work peculiar to their chosen line of work.

251. ADVANCED CIVIL ENGINEERING DRAWING. *Laboratory.*

Junior or Senior year or Graduate Course. Either term as arranged, six laboratory hours per week.

Curriculum III and Graduates of III (211, 212, 222).

Text: *Department Notes.*

Associate Professor Mann.

Complete design drawings are made for some project or intricate civil engineering structure, as for example, a steel bridge or a dam. Sets of plans and specifications for various structures are studied in detail.

252. ADVANCED MACHINE DRAWING. *Laboratory.*

Junior or Senior year or Graduate Course. Either term as arranged, three laboratory hours per week.

Elective (211, 212, 223).

Text: *Department Notes.*

Associate Professor Mann.

Complete designs of a more or less intricate machine are drawn, and sets of plans and specifications for such machines are studied in detail.

253. ADVANCED MAPPING AND TOPOGRAPHICAL DRAWING. *Laboratory.*

Junior or Senior year or Graduate Course. Either term as arranged, six laboratory hours per week.

Elective or graduate (211, 212, 222).

Text: *Department Notes.*

Associate Professor Mann.

A study of intricate topographic maps and mapping methods used by the United States Geological and Geodetic surveys and similar organizations; interpretation of topographic maps; and exercise in drawing of relatively difficult topographic maps from notes.

254. GRAPHIC CHARTS. *Laboratory.*

Junior or Senior years or Graduate Course. Either term as arranged, three laboratory hours per week.

Primarily for Curriculum IV, may be taken by students in any other, or by graduates (211).

Text: *Department Notes.*

Associate Professor Mann.

A study in the plotting of mathematical formulae and equations commonly met with by engineers and scientists. Interpretation and practical application of graphs.

ECONOMICS

PROFESSOR BOYCE.

The work in this department, while very valuable to the student from a purely business and professional point of view, is designed primarily to enable him to think logically and intelligently upon present-day problems—to enable him rightly to decide those questions of both public and private policy which come up before every one in his capacity as a member of the various groups in which he finds himself. In other words, the purpose of the courses here listed is to train for citizenship rather than for business in the narrow sense of the word. But even to the would-be purely business man, a knowledge of the economic and social problems of the day is no mean asset.

301. ECONOMIC HISTORY OF THE UNITED STATES. *Lectures.*

First term, three hours per week.
Elective. Professor Boyce.

The agricultural, commercial, and industrial development of the United States from the beginning of colonization down to the present; the effect upon this development of our natural resources, of slavery, of the British colonial policy, of our tariffs; why different sections developed along different lines.

(Not given in 1922-23).

302. ECONOMIC GEOGRAPHY. *Lectures.*

Second term, three hours per week.
Elective.
Professor Boyce.

Natural resources of the world; products and industries of different countries and the cause of their location.

(Not given in 1922-23).

305. PRINCIPLES OF ECONOMICS. *Lectures.*

Senior year, first term, three hours per week.
All curricula.
Professor Boyce.

The basic principles of the science and their practical applications to present-day problems.

306. PRINCIPLES OF ECONOMICS. *Lectures.*

Senior year, second term, three hours per week.
All curricula. Professor Boyce.
A continuation of 305.

307. LABOR PROBLEMS. *Lectures.*
Senior year, first term, three hours per week.
Elective (305-306).
Professor Boyce.

Origin of the labor problem; history of labor organizations; the strike, boycott and lock-out; collective bargaining; woman and child labor; conciliation and arbitration; profit-sharing and co-operation; social insurance; labor legislation.
(Given in 1922-23 and alternate years thereafter.)

308. BUSINESS ORGANIZATIONS. *Lectures.*
Second term, three hours per week.
Elective (305-306).
Professor Boyce.

A study of various types of business organizations, such as the individual entrepreneur, partnership, joint stock company, pool, trust, and holding company, setting forth their advantages and disadvantages, both to the public and to those conducting the business; a constructive program for the elimination of the evil features of large corporations and the preservation of their good ones; growth and probable effect of government regulations and control.
(Given in 1922-23 and alternate years thereafter.)

309. PRINCIPLES OF BUSINESS. *Lectures.*
First term, three hours per week.
Elective (305-306).
(Not given in 1922-23).

322. PRINCIPLES OF SOCIOLOGY. *Lectures.*
First term, 3 hours per week.
Elective.
Professor Boyce.

Theories and problems of social organization, social evolution, social control and social progress.
(Given in 1922-23 and alternate years thereafter).

323. SOCIAL PSYCHOLOGY. *Lectures.*
Second term, 3 hours per week.
Elective.
Professor Boyce.

A study of suggestibility, the crowd, imitation, custom, conflict, public opinion, and allied questions.
(Given in 1922-23 and alternate years thereafter).

ENGLISH AND MODERN FOREIGN LANGUAGES

Professor Barley, Assistant Professor Johnson, Assistant Professor Henning, Mr. Cambiaire, Mr. Lloyd.

ENGLISH.

400. RHETORIC AND COMPOSITION. *Lectures.*
Freshman year, first term, three hours per week.
All curricula.
Assistant Professors Johnson and Henning, Mr. Lloyd.

A study of the theory of exposition, with especial attention to the paragraph and to the correct and effective sentence. A large amount of written work is required of the student in order that he may gain facility in the use of clear, idiomatic expression. In many instances this written work is drawn from other courses pursued by the student, thereby correlating his practice in composition with his immediate interests and activities.

401. RHETORIC AND COMPOSITION. *Lectures.*
Freshman year, second term, three hours per week.
All curricula (400).
Assistant Professors Johnson and Henning, Mr. Lloyd.
A continuation of 400.

402. ADVANCED COMPOSITION. *Lectures.*
Sophomore year, either or both terms, three hours per week.
All curricula (400, 401).
Professor Barley, Assistant Professor Johnson.

This course is offered to students who prefer additional work in English composition to work in literature.

420. THE SHORT-STORY. *Lectures.*
Sophomore year, first term, three hours per week.
All curricula (400, 401).
Professor Barley or Assistant Professor Johnson.

An extended reading course in selected short-stories, together with a critical study of representative specimens of this literary type.

421. THE NOVEL. *Lectures.*

Sophomore year, second term, three hours per week.
All curricula (400, 401).

Professor Barley.

A reading course in representative English and American novels of the nineteenth century and of the present day.

422. MASTERPIECES. *Lectures.*

Sophomore year, first term, three hours per week.
All curricula (400, 401).

Professor Barley.

A critical study of selected masterpieces of the world's literature.

423. AMERICAN LITERATURE. *Lectures.*

Sophomore year, second term, three hours per week.
All curricula (400, 401).

Assistant Professor Johnson.

An advanced course in the history and development of literature in the United States, with particular reference to the period following the Civil War.

The successful completion of any two of courses 402, 420, 421, 422, 423 will fulfill the requirements in English in the Sophomore year.

424. SHAKESPEARE. *Lectures.*

Senior year, first term, three hours per week.
Elective (Sophomore requirements in English).

Professor Barley.

Five or six of Shakespeare's plays are carefully studied in class and several more are required as collateral reading.

425. CONTEMPORARY DRAMA. *Lectures.*

Senior year, either or both terms, three hours per week.
Elective (Sophomore requirements in English).

Professor Barley.

A reading course in the drama of the present day, supplemented with lectures.

403. ENGINEERING ENGLISH. *Lectures.*

Senior year, first term, two hours per week.
Elective in I, II, V, VI, VII. Required in III. (Sophomore requirements in English).

Professor Barley.

An advanced course in oral and written technical reports and in the details of engineering writing.

404. DISCUSSION AND DEBATE. *Lectures.*
Senior year, second term, two hours per week.
Elective in I, III, V, VI, VII (Sophomore requirements in English).

Professor Barley.

The primary aim of the course is to give students training in clear and logical oral expression. Topics of general and of engineering interest will be discussed and debated.

MODERN FOREIGN LANGUAGES.

The modern foreign languages offered are German, French and Spanish. Ten hours of German are required in Curriculum VII and ten hours of either German or French are required in Curriculum IV. Languages are elective in Curricula I, III, V, VI.

At present the United States Geological Survey requires German or French in its Civil Service examinations. Students who expect to qualify for this work are advised to elect one or both of these languages.

Students who expect to engage in work in Central America or South America are advised to elect Spanish.

No advanced standing will be given for high school credit in language except by examination.

450. ELEMENTARY GERMAN. *Lectures.*
Senior year, first term, five hours per week.
Curricula IV, VII. Elective in I, III, V, VI.

Assistant Professor Henning.

451. SCIENTIFIC GERMAN. *Lectures.*
Senior year, second term, five hours per week.
Curricula IV, VII (450). Elective in I, III, V, VI (450).

Assistant Professor Henning.

460. ELEMENTARY FRENCH. *Lectures.*
Senior year, first term, five hours per week.
Elective.

Mr. Cambiaire.

461. SCIENTIFIC FRENCH. *Lectures.*
Senior year, second term, five hours per week.
Elective (460).

Mr. Cambiaire.

470. ELEMENTARY SPANISH. *Lectures.*
Senior year, first term, five hours per week.
Elective.

Mr. Cambiaire.

471. ADVANCED SPANISH. *Lectures.*
Senior year, second term, five hours per week.
Elective (470). Mr. Cambiaire.

GEOLOGY AND MINERALOGY

Professor Dake, Associate Professor Muilenburg, Assistant Professor Bridge, Mr. Ingerson.

EQUIPMENT.

The geological and mineralogical laboratories are on the second floor of Norwood Hall. The equipment of the department includes reference, working, and cabinet collections of minerals, ores, rocks and fossils and many specimens illustrating metallurgical processes; a working collection of wooden and glass crystal models and natural crystals; a complete set of maps and reports; a number of geological relief models, including the large relief map of the state; a large collection of thin sections of minerals and rocks; and several thousand lantern slides illustrating the topics discussed in the classroom. Besides the above mentioned there are instruments for geological surveys, petrographic microscopes, and machines for trimming specimens and grinding thin sections.

There is also a set of thirty-five hundred specimens representing the mineral wealth of Missouri, consisting of coal, clays of many sorts, building stones, and ores of lead, zinc, iron, and copper, as well as gangue minerals occurring with the metalliferous deposits of the state. There is a complete collection of economic minerals of Missouri and a good collection of economic minerals representing the world at large. This collection was part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago and was presented to the School of Mines and Metallurgy by the General Assembly in 1895. Moreover, the specimens, models, and maps constituting the Missouri Mining Exhibit at the St. Louis Exposition were assigned to the school by the State Board of Equalization, thus giving the school a large amount of valuable material.

The museums contain specimens from many parts of the world. The important mining districts of the state are especially well represented by the economic collection from Southwestern Missouri, and by collections from the Missouri Building at the St. Louis Exposition.

COURSES.

501. CRYSTALLOGRAPHY. *Lectures and Laboratory.*

First term, 3 hours per week.
Elective.
Text: Butler, *Geometrical Crystallography.*
Associate Professor Muilenburg.

Elementary crystallography, including the study of models and natural crystals. The object of the course is to give the student an understanding of the general principles of crystallography and the ability to recognize crystal forms, especially the systems. The lectures are given during the regular laboratory time. This course may be taken independently or in conjunction with Petrography.

503. MINERALOGY. *Laboratory.*

Sophomore year, first term, six hours per week.
Curricula I, II, IV and VII (3 and 4).
Texts: Dana, *Textbook of Mineralogy.*
Manual of Mineralogy.
Mr. Ingerson.

A brief summary of the principles of crystallography as applied to the identification of minerals, followed by a thorough drill in the recognition of about one hundred and seventy-five species. Determination of unknowns by means of the blowpipe forms part of the laboratory work. The lectures are given during the regular laboratory time.

505. ROCKS AND MINERALS. *Laboratory.*

Junior year, second term, three hours per week.
Curriculum III (3 and 4).
Text: Ries and Watson, *Engineering Geology.*
Mr. Ingerson.

A study of the common ore and rock-forming minerals and types of rocks. The lectures are given during the regular laboratory time. This course is intended for Civil Engineering students, the same ground being covered more thoroughly in courses 503 and 530, so that full credit may not be had for it and either of these two, and it may not be substituted for part of them.

OPTICAL MINERALOGY.—See Geology 532.

510. GENERAL GEOLOGY. *Lectures.*

Junior year, first term, three hours per week.
Curriculum I (503 to be accompanied by 530).
Text: Cleland, *Geology, Physical and Historical.*
Professor Dake.

Dynamic geology. A somewhat detailed account of geologic processes. The larger topics are treated more exhaustively than in the required text. Local field trips.

512. GENERAL GEOLOGY. *Lectures.*

Junior year, second term, three hours per week.
Curriculum I (510 to be accompanied by 513).
Text: Cleland, *Geology, Physical and Historical.*
Professor Dake, Assistant Professor Bridge.

Introductory structural and historical geology. Typical geologic structures and their effects on the physiographical development of the earth's surface are considered for the first eight weeks. Geologic history is then traced from the beginning of the record to the present, as much attention as possible being paid to the rock systems and their contained fossils, with reference to geographic changes and organic evolution.

513. GENERAL GEOLOGY. *Laboratory.*

Junior year, second term, six hours per week.
Curriculum I (510 to be accompanied by 512).
References: Hayes, *Handbook for Field Geologists.*
Geikie, *Structural and Field Geology.*
U. S. Geological Survey, *Prof. Paper, No.* 60.
Professor Dake, Mr. Ingerson.

Laboratory exercises in reading topographic and geologic maps, and in the construction of profile and geologic sections and simple geologic maps. These exercises are designed to illustrate the subject matter of the earlier lectures of course 512, and occupy nine weeks; excursions and field practice in elementary geologic mapping the remainder of the semester.

514. GENERAL GEOLOGY. *Lectures.*

Junior year, second term, three hours per week.
Curriculum III (to be accompanied by 505).
Text: Ries and Watson, *Engineering Geology.*
Assistant Professor Bridge.

An introductory course in general geology adapted to the needs of students in Civil Engineering. The work covers general geology with such detail as is possible in the time allowed.

516. GEOLOGY OF THE UNITED STATES. *Lectures.*

Senior year, first semester, three hours per week.
Elective (512 and 513).
Text: Blackwelder, *Handbook of Regional Geology—the United States.*

Assistant Professor Bridge.

The physiography and stratigraphy, economic products, and geologic history and structure of the chief geologic divisions of the United States are summarized in the lectures.

518. STRATIGRAPHY. *Lectures.*

Senior year, first term, three hours per week.
Curriculum I (512, 513 and 530).

Assistant Professor Bridge.

A course in stratigraphy, with special emphasis given to the principles of sedimentation.

520. STRUCTURAL GEOLOGY. *Lectures.*

Senior year, second term, three hours per week.
Curriculum I (512, 513 and 530).
Text: Geikie, *Structural and Field Geology.*

Professor Dake.

An advanced course in the study of rock deformation, including a review of the theories of the origin of the earth; a discussion of the zones of rock fracture and rock flowage, a classification and discussion of cleavage, joints, faults, folds, autoclastic rocks, conglomerates and pseudo-conglomerates; and a consideration of mountain building forces, with application to special districts. The course is intended to follow 518.

521. ADVANCED GEOLOGY. *Laboratory.*

Senior year, second term, six hours per week.
Elective (512 and 513).

Associate Professor Muilenburg.

An advanced course in the study and interpretation of topographic and geologic maps.

522. GEOLOGY CONFERENCE. *Lectures.*

Senior year, second term, one hour per week.
Elective (518 or 540).

Professor Dake.

The conference consists of a discussion by the students and instructors of geologic problems and literature, each student being assigned certain work upon which he must report to the class.

530. LITHOLOGY. *Lectures and Laboratory.*

Junior year, first term, one lecture and three hours laboratory per week.

Curriculum I (503).

Text: Kemp, *Handbook of Rocks.*

Associate Professor Muilenburg.

A study of the structure, texture, mineral and chemical composition and the manner of formation and occurrences of igneous, sedimentary, and metamorphic rocks. Emphasis is placed on the megascopic character as seen with the naked eye or by aid of a hand magnifying glass, enabling the student to classify rocks in the field.

532. PETROGRAPHY. *Lectures and Laboratory.*

Senior year, first term, two hours lectures and nine hours laboratory per week.

Curriculum I (512, 513 and 530; 1002 and 1003).

Text: Luquer, *Minerals in Rock Sections.*

References: Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannsen, *Determination of Rock Forming Minerals.*
Weinschenk, *Petrographic Methods.*

Associate Professor Muilenburg.

The semester is devoted to the study of optics as applied to the determination of minerals by the polarizing microscope, the identification of minerals in thin sections, and the preparation of material for microscopic study.

534. PETROGRAPHY. *Lectures and Laboratory.*

Senior year, second term, two hours lectures and six hours laboratory per week.

Curriculum I (532).

References: Iddings, *Rock Minerals.*
Winchell, *Elements of Optical Mineralogy.*
Johannsen, *Determination of Rock Forming Minerals.*
Weinschenk, *Petrographic Methods.*

Associate Professor Muilenburg.

A study of the origin, classification, and nomenclature, relations and alterations of rocks, together with the petrographic analysis and the recalculation of the chemical analyses of rocks. The laboratory also includes the description of rock sections and making reports on examinations.

540. ECONOMIC GEOLOGY. *Lectures.*

Senior year, first term, three hours per week.

Curriculum I (512, 513 and 530).

Texts: Ries, *Economic Geology.*

Emmons, *Principles of Economic Geology.*

References: Largely to reports by the United States and State Geological Surveys.

Associate Professor Muilenburg.

A study of the origin, occurrence and distribution of the metallic ores. Various type deposits of the world are considered, special attention being given to those of the United States. Written reports are required for each district studied, reference always being made to the original reports, thus familiarizing the student with the various technical publications and their usage. The ores of the following metals are considered: Zinc, lead, copper, gold, silver, nickel, cobalt, iron, manganese, tin, mercury, tungsten, platinum and aluminum. Trips to local points of interest. Candidates for the degree of Bachelor of Science in Mine Engineering taking this course must also take the geology part of course 560, Senior Trip.

542. ECONOMIC GEOLOGY. *Lectures.*

Senior year, second term, three hours per week.

Curriculum I (512, 513 and 530).

Text: Ries, *Economic Geology.*

Associate Professor Muilenburg.

A study of the origin, occurrence and distribution of the economic deposits of the non-metals. Reference is made to those technical reports which describe the most important deposits, and a written summary is required for each district studied. The subjects covered are as follows: Coal, oil and gas, clays, cements, gypsum, salt, sulphur, sulphides, building stone, abrasives, gems, soils and fertilizers. Trips to local points of interest.

Students taking this course who do not take course 560 will be given special work while the rest of the class is taking the Senior Trip.

543. FIELD GEOLOGY. *Laboratory.*

Senior year, first term, six hours per week.
Curriculum I (512 and 513).
Professor Dake, Professor Cooke.

The course consists of both field and laboratory work, the two being varied to suit the weather. The field work consists of making topographic and geologic maps, with suitable sections and reports of assigned areas. The laboratory work includes the calculation of field notes and making maps and the final drafting of the field work. The instruments used include the plane table, hand level, aneroid barometer and telescopic alidade.

544. OIL AND GAS. *Lectures.*

Senior year, first term, three hours per week.
Curriculum I (512 and 513).
Text: Emmons, *Geology of Petroleum.*
References: Various treatises on oil and gas and geological reports.
Professor Dake.

A detailed study of the oil and gas deposits of the United States, with brief reference to foreign fields. The origin and occurrence of oil and gas as well as the geological and structural conditions of the various fields is taken up, followed by a study of field methods in petroleum geology.

545. OIL AND GAS. *Laboratory.*

Senior year, first term, three hours per week.
Curriculum I (512 and 513 to be accompanied by 544).
Professor Dake.

Laboratory work in the interpretation and preparation of production charts, geologic and structure maps.

551. PALEONTOLOGY. *Laboratory.*

Junior or Senior year, first term, six hours laboratory per week.
Curriculum I.
Text: Shimer, *Introduction to the Study of Fossils.*
Assistant Professor Bridge.

A general introduction to the study of invertebrate fossils. Emphasis is placed on the index fossils of the different periods. The necessary lectures are given during the laboratory periods.

553. PALEONTOLOGY. *Laboratory.*

Junior or Senior year, second term, six hours laboratory per week.

Curriculum I (551).

No text required; reference being made to the various paleontological publications of the Federal and State Surveys, Scientific Societies, etc.

Assistant Professor Bridge.

A study of a number of faunas representative of the several geologic periods. Local field trips, and identification of collections made on these trips, during the latter part of the semester.

570. SPECIAL GEOLOGY.

Senior year, first or second term.

Special studies in geology, hours and subjects to be arranged with each student.

599. SENIOR TRIP.

Senior year, second term.

Curriculum I (540).

Associate Professor Muilenburg.

During the second semester of the Senior year a trip is taken to Joplin, St. Louis, Flat River, and other points in the Missouri Lead Districts, for the purpose of studying mining, ore dressing, smelting, geology, and power plants in these districts. The geology portion of these trips is required of all candidates for the degree in Mining Engineering.

NOTE.

The attention of those contemplating taking the United States Civil Service examination for the Geological Survey is called to the fact that all candidates are required to pass a reading examination in either French or German.

HYGIENE AND STUDENT HEALTH

ASSOCIATE PROFESSOR SHAW, MR. MILLAR.

The Department of Hygiene and Student Health is under the charge of the Student Health Adviser, a physician, who keeps himself informed as to the health of the students. Each student, soon after he enters school, and thereafter as he desires, is given a careful physical examination. The result of such examination is recorded, and is used by the Department of Physical Training in determining the kind of exercise which shall be assigned to the student. Every case of illness must be immediately reported to the Student Health Adviser.

The offices and laboratories of the department are located in the basement of Parker Hall. The equipment includes an X-ray outfit. Students may receive X-ray examination without charge when, in the opinion of the Student Health Adviser, such examination is advisable.

Lectures on personal hygiene are given to all first year students. The department also offers the courses in zoology and botany which are required in Curriculum IV. Bacteriology is offered to students in Curricula IV and VII as an important subject bearing on chemical processes and on hygiene.

COURSES.

60. HYGIENE. *Lectures.*

Freshman year, first term, one hour per week.
All curricula.

Associate Professor Shaw.

61. GENERAL ZOOLOGY. *Lectures.*

Freshman year, first term, 3 hours per week.
Curriculum IV.

Associate Professor Shaw.

Lectures introductory to the study of the entire field of animal life.

62. GENERAL ZOOLOGY. *Laboratory.*

Freshman year, first term, six hours per week.
Curriculum IV.

Associate Professor Shaw.

Laboratory to accompany course 61.

63. GENERAL BOTANY. *Lectures.*

Freshman year, second term, three hours per week.
Curriculum IV (61).

Associate Professor Shaw.

A general course presenting the fundamental features of plant life.

64. GENERAL BOTANY. *Laboratory.*

Freshman year, second term, six hours per week.
Curriculum IV.

Associate Professor Shaw.

Laboratory and field work to accompany course 63.

65. GENERAL BACTERIOLOGY. *Lectures.*

Junior or Senior year, first term, two hour per week.
Elective (Junior standing).

Associate Professor Shaw.

This course deals with general bacteriology, and with the relation of bacteria to the public health.

66. GENERAL BACTERIOLOGY. *Laboratory.*

Junior or Senior year, first term, four hours per week.
Elective (Junior standing).

Associate Professor Shaw.

The laboratory course to accompany course 65. The work deals with the preparation of media, cultural and staining methods, diagnostic tests, and the examination of the more common bacteria.

67. SPECIAL BACTERIOLOGY. *Laboratory.*

Junior or Senior year, three hours or more per week.
Elective (65 and 66).

Associate Professor Shaw.

The development of bacteriological technique in any chosen definite field. Credit to be arranged.

68. MICROSCOPY OF TECHNICAL PRODUCTS.

Laboratory.

Second term, three hours per week.
Elective (62).
Text: Hanausek, Winton, *Microscopy of Technical Products.*
Associate Professor Shaw.

The microscopical examination and identification of technical materials, including the histological preparation of the sections. The work is supplemented by informal lectures in the laboratory.

69. TECHNICAL MICROBIOLOGY. *Laboratory.*

Junior or Senior year, 6 hours per week.
Elective (65 and 66).
Associate Professor Shaw.

The utilization of micro-organisms in the arts and industries. Credit to be arranged.

LIBRARY

MRS. NORVILLE, ACTING LIBRARIAN; MISS JOHNSON, MRS. HAYES.

The Library occupies the second floor of Parker Hall. Its quarters consist of a large, well-lighted reading room, equipped with a double-deck Snead stack, capacity 45,000 volumes and a suite of offices and workrooms for the library staff. All equipment is new and modern.

The collection of books numbers about 25,000 carefully selected volumes, together with a large collection of pamphlets, bulletins and reports of mining companies. The library has one of the most complete files in the middle West of American and foreign technical journals and the proceedings of scientific and engineering societies. These resources are constantly increased with reference to the different courses of study, while at the same time there is kept in view the development of a well-rounded general library. The bulk of the collection consists of work in the sciences, chiefly geology, physics, chemistry, and the useful arts, the main part of this division being engineering and mining treatises. Besides these collections, the library has the representative works of contemporary American and English literature, a good section of fiction, some biography, and the latest books of description and travel, the latter division being kept especially strong, so that the students may be informed concerning the manners and customs of the people and the characteristics of the countries into which they are likely to go to follow their vocation.

The library is a subscriber to the standard technical periodicals and the publications and transactions of societies and congresses. The leading general magazines are taken for recreational reading. The contents of the back files of this material are made available through the general periodical indexes, the engineering and mining indexes, and other bibliographic aids.

The Dewey decimal system of classification is used and the resources of the collection are made available through a full dictionary catalogue of authors, titles, and subjects.

Interlibrary loan arrangements exist between this library and the Library of Congress, the St. Louis Public Library, the John Crerar Library of Chicago, the University Library at Columbia and a number of other large libraries. By this arrangement books not in the collection at the School of Mines may be borrowed for the use of the students for a limited time.

The reading room is open daily from 8 to 12, 1 to 6, and 7 to 8:30; Sunday 3 to 5. Books and periodicals may be borrowed by all officers and students of the school, and by others having permission.

A noteworthy feature of the instruction in all departments at the Missouri School of Mines is the emphasis which is placed upon the use of the library and upon the study of engineering literature.

In connection with the Freshman English courses, the librarian gives, each year, a brief series of lectures explaining the system of classification and the arrangement of books in the library, and the use of the catalogue and the various collective indexes and other bibliographic aids. These lectures are supplemented by problems in the library, and by individual instruction.

MATHEMATICS

PROFESSOR DEAN, ASSISTANT PROFESSOR PRITCHARD, MR. HINSCH.

The study of mathematics is required of all regular students during the Freshman and Sophomore years. During the Junior and Senior years elective courses are offered in advanced calculus, mathematical physics and chemistry and statistical mechanics.

600. PLANE AND SPHERICAL TRIGONOMETRY. *Lectures.*
Freshman year, first term, five hours per week.
All curricula.
Text: Bauer and Brooke, *Trigonometry and Tables.*
Professor Dean, Assistant Professor Pritchard, Mr. Hinsch.

601. ANALYTICAL GEOMETRY. *Lectures.*
Freshman year, second term, five hours per week.
All curricula (600).
Text: Roberts and Colpitts, *Analytical Geometry.*
Professor Dean, Assistant Professor Pritchard, Mr. Hinsch.

The object of this course is to familiarize the student with methods, rather than with any particular set of curves, or surfaces. The fundamental theorems and formulae of the differential calculus are developed, and applied in finding the equations of tangents and normals to curves and surfaces, to the solution of simple problems in maxima and minima, and in curve tracing. For this work manuscript notes are furnished by the Department.

602. DIFFERENTIAL CALCULUS. *Lectures.*
Sophomore year, first term, four hours per week.
All curricula, except IV (601).
Text: Bailey and Woods, *Analytical Geometry and Calculus.*
Professor Dean, Assistant Professor Pritchard, Mr. Hinsch.

Derivation of formulae for differentials and derivatives and their application in solution of problems involving rates, velocities, accelerations, tracing of curves, maxima and minima, radius of curvature of curves and surfaces.

The integration of simple forms is taken up and applied in finding areas, centres of gravity and moments of inertia.

603. INTEGRAL CALCULUS. *Lectures.*

Sophomore year, second term, four hours per week.
All curricula, except IV (602).
Text: Bailey and Woods, *Analytical Geometry and Calculus.*
Professor Dean, Mr. Hinsch, Assistant Professor Pritchard.

The principles of integration, with special stress on the forms occurring in mechanics and physics. Evaluation of areas, moments, moments of inertia, determination centre of gravity and centre of pressure. Differential equations of mechanics and physics and their application in solution of problems in physics and mechanics.

609. ADVANCED CALCULUS. *Lectures.*

Junior or Senior year, five hours per week.
Elective (603).
Texts: Wilson, *Advanced Calculus.*
Woods and Bailey, *Mathematical Analysis*, Vol, II.
Cohen, *Differential Equations.*
Professor Dean, Assistant Professor Pritchard.

610. MATHEMATICAL PHYSICS AND CHEMISTRY. *Lectures.*

Junior or Senior year elective, five hours per week (609).
Professor Dean.

Advanced mathematical theory of heat, light, sound, electricity and magnetism, thermodynamics, thermochemistry, electrochemistry, chemical statics and dynamics. Lectures, notes and problems.

611. STATISTICAL MECHANICS. *Lectures.*

Junior or Senior year elective, five hours per week (610).
Lectures, notes and problems.
Professor Dean.

Probability and least squares, kinetic theory of gases, kinetic theories in thermodynamics and chemistry, applications of Hamilton's dynamical methods, electron theory.

613. HARMONIC FUNCTIONS. *Lectures.*

Senior year elective, five hours per week (609).
Texts: Byerly, *Fourier's Series and Spherical Harmonics.*
Gray and Mathews, *Bessel Functions.*
Professor Dean.

MECHANICAL ENGINEERING

Professor Jackson, Mr. Miller, Mr. Underwood, Mr. Corey.

Mechanical Engineering is perhaps the broadest of the engineering courses.

It is the object of this department to give the student a comprehensive training in the fundamentals of mechanical engineering which will be of use to him in practically any industry which he wishes to pursue.

The lecture rooms, offices, and laboratories of the department are housed in Mechanical Hall and in the school power plant building. The equipment includes steam driven A. C. and D. C. generators, water tube and fire tube boilers, turbines, separate steam engines used for tests, compressors, fans, centrifugal and reciprocating pumping machinery, condensers and auxiliaries, internal combustion engines and such pieces of laboratory apparatus as are needed in making tests on all of these.

The various shops, in which the student is given training in forging, pattern making, moulding, and machine tool work, are well equipped to accommodate classes. The forge shop is fitted with down draft forges, anvils, hand forge tools, and such power tools as hammers, shears, grinding wheels, heat treatment furnaces and an automatic drill sharpener. The pattern making shop is equipped with a 28-foot cupola, core oven, ladles and a complete set of hand moulding tools. In the pattern shop are wood lathes, benches, planers, band saw, morticers, and complete sets of woodworking tools. The machine shop is equipped with belt and motor driven lathes, milling machines, planer, shaper, drill presses, power saws, grinding machines and grinding wheels, various tool sharpeners, and sets of hand metal working tools and work benches. There is a five station oxy-acetylene welding outfit in connection with the shops.

There is a reference or report room where reference books belonging to the department are available for use in writing reports or preparing subjects.

The curriculum in mechanical engineering has been worked out so as to give as thorough and at the same time as well balanced a course as can be given in four years. On this account candidates for a degree from this department are not allowed an unrestricted choice of subjects. There is, however, no objection to a student's electing courses in other departments provided he completes the required amount of work in this department.

COURSES.

701. FORGE SHOP. *Laboratory.*

Freshman year, second term, six hours per week.
Curricula V, VI.

Mr. Underwood.

Instruction in elementary forge work.

702. PATTERN SHOP AND FOUNDRY.

Lectures and Laboratory.

Sophomore year, first term, one lecture and six laboratory hours per week.
Curricula V, VI (701).

Mr. Underwood.

Elementary pattern making and foundry operations.

703. MACHINE SHOP. Laboratory.

Sophomore year, second term, six laboratory hours per week.
Curricula V, VI (701, 702).

Mr. Corey, Mr. Underwood and assistants.

Elementary machine shop work, including metal welding.

710. THERMODYNAMICS. *Lectures.*

Junior year, first term, three hours per week.
Curriculum V (602, 603, 1002, 1003).
Text: Moyer, Caldwood and Potter, *Elements of Engineering Thermodynamics.*

Professor Jackson.

A study of the theory of perfect gases, vapors, heat engine cycles, steam engine cycles, thermal efficiencies, and flow of steam and gases thru nozzles and orifices.

711. HEATING AND VENTILATING. *Lectures.*

Senior year, second term, two hours per week.
Curriculum V (710).
Text: Harding and Willard, *Heating and Ventilation.*

Professor Jackson.

The theory and application of the principles of heating and ventilation. The parts of the subject studied include the heat transmission in buildings; types of heating boilers, radiators and steam coils, steam, hot water, and hot air heating systems, air conditioning and ventilation.

713. STEAM AND GAS ENGINES. *Lectures.*

Junior year, second term, three recitations per week.
Curriculum V.
Text: Streeter, *Internal Combustion Engines.*

Mr. Miller.

The theory, thermodynamic and mechanical principles of steam and internal combustion engines, including a study of type, governing, economy, selection, and suitability of various engines for different purposes.

714. MECHANISMS. *Laboratory.*

Junior year, first term, six laboratory hours per week.
Curriculum V.
Text: Keown, *Mechanisms.*

Professor Jackson.

The graphical solution of kinematic problems, such as velocity diagrams, instantaneous centers, various types of cams and motions layout of gear teeth, bevel gears and belting.

715. MACHINE DESIGN. *Lectures.*

Junior year, first term, two recitations per week.
Curriculum V, VI.
Text: Leutwiler, *Machine Design.*

Mr. Miller.

The fundamentals in the design of machine parts, such as materials, stresses, riveted joints, screws, spur and bevel gears, clutches and couplings, transmissions, and such other elements as enter into the design of machines.

716. MACHINE DESIGN. *Lectures and Laboratory.*

Junior year, second term, three lecture and three laboratory hours per week.
Curriculum V, VI (714, 715, 718).
Text: Leutwiler, *Machine Design.*

Mr. Miller.

Design of some simple machine or of a boiler.

718. MECHANISMS. *Laboratory.*

Junior year, first term, three laboratory hours per week.
Curriculum VI.
Text: Keown, *Mechanisms.*

Professor Jackson.

This course is the same as 714, but presented in 3 hours per week.

722. ADVANCED MACHINE DESIGN. *Lectures.*

Senior year, first term, two hours per week.
Curriculum V (716).
Text: Leutwiler, *Machine Design.*

Mr. Miller.

This course offers work of a more advanced character than 716. The design of some machine such as a press, shear, punch, crane, power hammer or similar machine will be undertaken.

724. ADVANCED MACHINE DESIGN. *Laboratory.*

Senior year, first term, six hours laboratory per week.
Curriculum V and VI (716).
Text as in 722.

Mr. Miller.

Laboratory work which may accompany 722.

725. POWER PLANT DESIGN. *Lectures and Laboratory.*

Senior year, second term, two hours lecture and six hours laboratory per week.
Curriculum V.
Text: Harding and Willard, *Power Plants and Refrigeration.*

Professor Jackson.

The work in this course will consist of the design of the building and the selection and layout of the equipment for a complete power plant.

726. VALVE GEARS. *Lectures.*

Junior year, second term, two hours per week.
Curriculum V (714).
Text: Dalby, *Valves and Valve Gear Mechanisms.*

Professor Jackson.

A study of valves and valve setting, including valve diagrams, different types of valve gears, and governors.

727. REFRIGERATION AND COMPRESSED AIR. *Lectures.*

Senior year, second term, two hours per week.
Curriculum V (710).

Professor Jackson.

A study of the thermodynamics and mechanical equipment of the refrigerating plant covering air, vapor, and ammonia machines. Air compressors and appliances are included in this course.

728. STEAM AND HYDRAULIC TURBINES. *Lectures.*

Senior year, first term, three hours per week.
Curriculum V (131, 713).
Text: Daugherty, *Hydraulic Turbines.*

Mr. Miller.

Continuation of 713. The theory and design of steam and hydraulic turbines, types, governing, installation and characteristics.

730. POWER PLANTS. *Lectures.*

Senior year, first term, three recitations per week.
Curriculum V (710, 713).
Text: Gebhardt, *Steam Power Plant Engineering.*

Professor Jackson.

The selection of power plant equipment and fuels, operation and location of plants.

731. POWER PLANTS. *Lectures.*

Senior year, second term, three lectures per week.
Curriculum V (720).
Text: Gebhardt, *Steam Power Plant Engineering.*

Professor Jackson.

A continuation of 730.

770. POWER PLANTS. *Lectures and Laboratory.*

Junior or Senior year, first term, three lectures and three laboratory hours per week.
Curricula I, II, VI, VII (603, 604, 1002, 1003).

Professor Jackson.

A study of power plants in general. The work will include steam boiler types, fuels, combustion principles, the steam engine, elementary thermodynamics, valve gears, governing, indicating, testing, economies and operation. In the laboratory the work will include the testing and calibration of minor power plant apparatus and simple engine tests.

771. POWER PLANTS. *Lectures and Laboratory.*

Junior or Senior years, second term, three lectures and three laboratory hours per week.
Curricula I, II, VI, VII (770).

Professor Jackson.

A continuation of course 770. The work will include steam turbines, internal combustion engines, gas producers, and auxiliary apparatus. In the laboratory tests will be made on boilers, engines, turbines, and auxiliary apparatus.

774. POWER PLANT LABORATORY. *Laboratory.*

Junior year, first term, three hours per week.
Curriculum V.

Mr. Miller.

The work will consist of an introduction to laboratory methods and the study and calibration of testing apparatus. There will also be some simple tests on engines and power plant auxiliaries.

775. POWER PLANT LABORATORY. *Laboratory.*

Junior year, second term, three hours per week.
Curriculum V (774).

Mr. Miller.

A continuation of 774, in which tests are made on steam and internal combustion engines, compressed air machinery, and hydraulic apparatus.

776. POWER PLANT LABORATORY. *Laboratory.*

Senior year, first term, three hours per week.
Curriculum V (775).

Mr. Miller.

In this course will be studied steam and hydraulic turbines, centrifugal pumps, air fans, and steam power plant auxiliary apparatus such as boiler feed pumps, condensing machinery, feed water heaters, pumping machinery and their relation to the plant.

777. POWER PLANT LABORATORY. *Laboratory.*

Senior year, second term, three hours per week.
Curriculum V (776).

Mr. Miller.

A continuation of the work in 776. In this course a test will be run on the power plant of the School Experimental Mine and a boiler test at the School Power Plant. The students will also operate the Power Plant, under supervision, the work to include all steps from firing the boilers to distributing the power at the switch boards. There will also be some engine tests.

780. MINING MACHINERY. *Lectures and Laboratory.*

Senior year, first term, three hours lecture and three hours laboratory work per week.

Elective in Curriculum I.

Professor Jackson.

This course deals with hoists, air compressors, air appliances, pumps, fans, and engines. The laboratory work includes the measurement of air displaced by fans and compressors and the duty of centrifugal and reciprocating pumps.

MECHANICS

Professor Garrett, Mr. Updike, Mr. Cairns.

651. THEORETICAL MECHANICS. *Lectures.*

Sophomore year, second term or Junior year, first term, three hours per week.

All curricula except IV (602 and 1000).

Text: Poorman, *Applied Mechanics.*

Professor Garrett.

652. MECHANICS OF MATERIALS. *Lectures.*

Junior year, first or second term, three hours per week.

All curricula except IV (651).

Professor Garrett.

653. MATERIALS LABORATORY. *Laboratory.*

Junior year, first or second term, three hours per week.

All curricula except IV (651 to accompany 652).

Mr. Updike, Mr. Cairns.

Includes the study of testing machines and strain-measuring apparatus; and physical tests in tension, compression, flexure and torsion of cast iron, wrought iron, structural steel, timber, etc., laboratory and computing-room periods.

654. ADVANCED THEORETICAL MECHANICS. *Lectures.*

Elective. Three hours per week.

Professor Garrett.

A continuation of course 651, giving special attention to dynamics, with technical applications.

655. ADVANCED MECHANICS OF MATERIALS. *Lectures.*

Elective. Three hours per week.

Professor Garrett.

This course begins with a more advanced study of certain parts of the work covered in 652, and includes a further discussion of such subjects as combined stresses, inertia circle and ellipse, kern, beams of unsymmetrical section, curved beams, flat plates and thick cylinders.

METALLURGY AND ORE DRESSING

PROFESSOR CLAYTON, ASSOCIATE PROFESSOR BAINS, MR. THORNBERRY, MR. UPDIKE, MR. CAIRNS.

The assay laboratory includes the furnace room, the parting room and the balance room. In the furnace room are twenty coal-fired double muffle furnaces, twelve gasoline-fired furnaces and ten coke-fired furnaces. The balance room contains twenty-four balances suitable for weighing gold. The parting room contains the necessary hot plates and annealing muffles.

There is, in the main furnace room, a circular water-jacket blast furnace 20 inches in diameter at the tuyeres and 7-foot smelting column. This furnace is used for lead and copper smelting. For roasting ores a hand reverberatory furnace, with a hearth 4½ by 9 feet, is provided. This laboratory contains also an experimental pot roaster and an experimental zinc distilling furnace.

The pyrometry laboratory is well equipped with various types of instruments suitable for measuring temperatures up to 3,000 degrees F. Two Leeds and Northrup recording potentiometers, one indicating potentiometer, one Wilson-Maeulin tapalog, and several millivoltmeters constitute the instruments suitable for measuring temperatures up to 2,700 degrees F. Both base metal and noble metal couple with compensating leads can be used interchangeably on the double-range instruments.

A Wanner optical pyrometer and a Leeds and Northrup optical pyrometer will measure the highest attainable temperature.

Electric furnaces capable of attaining temperatures up to 3,600 degrees F. are used for melting metals for standardizing the various pyrometers.

The metallography laboratory, equipped with horizontal polishing machines, Bausch and Lomb and Holz metallurgical microscopes and one inverted microscope, furnishes ample facilities for a complete study of metals and their alloys. Some 1,000 specimens form an interesting collection for showing the effect of mechanical and thermal treatment on ferrous and non-ferrous alloys.

It is recognized that the school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim to give such training in the fundamental principles and their application that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

The ore sample room is well stocked, containing about one thousand samples, all carefully prepared and assayed. The samples are characteristic ores and metallurgical products such as mattes, bullions, cyanide solutions, fumes, etc.

The equipment of the ore dressing laboratory includes, in the crushing and sampling department, a gyratory breaker, a Dodge breaker, a pair of 9-inch by 12-inch rolls, two plane shaking screens, two Vezin samplers, two bucket elevators, three belt conveyors and six ore storage bins, each equipped with an automatic feeder. For fine crushing and amalgamation tests there is provided a three-stamp mill, with amalgamation plates.

Ores are prepared for concentration by the following series of machines: Three trommel screens, a Richards pulsator classifier, a four-spigot Richards vortex classifier, a three-spigot cone classifier, a small Tamarack classifier, and four Callow settling cones.

Methods of concentrating coarsely-crushed ores are illustrated by three five-cell differential motion Harz jigs, a Richards pulsator jig, and a small model of the Hancock jig. Sands are treated on two laboratory-size Wilfley tables, one laboratory Card table, one Deister-Overstrom table, and Diester Plat-O sand table. A four-foot Frue vanner and a five-foot Sperry slimer are provided for the treatment of fine materials.

Two direct-connected motor-driven centrifugal sand pumps are used for elevating finely-crushed ore to the screening and classification system.

The sample finishing room contains a small Blake crusher, a small gyratory breaker, a disc grinder, a coffey mill, a pair of rolls, a number of bucking boards and mullers, a laboratory tube mill, a Ro-Tap testing sieve shaker and an electric sampler dryer.

Ores suited to a magnetic concentration are treated on a Knowles magnetic separator.

The equipment of the flotation laboratory is complete and modern. It includes eight machines of the mineral separation type, four of which are of the modified air-life type, one Janney machine (the gift of D. C. Jackling), and one Callow machine. Each machine is arranged so that it can be run independently of all others or in combination.

COURSES.

801. FIRE ASSAYING. *Lectures.*

Sophomore year, second term, two hours per week.
Curricula I and II (503).
Texts: Fulton, *Assaying.*
Smith, *Sampling and Assaying of the Precious Metals.*
Professor Clayton, Assistant Professor Bains.

The theory of fire assaying, by scorification and crucible methods, of ores and metallurgical products.

802. FIRE ASSAYING. *Laboratory.*

Sophomore year, second term, six hours per week.
Curricula I and II (801).
Professor Clayton, Associate Professor Bains, Mr. Updike.

In this laboratory work ores and metallurgical products are assayed by fire and by combination methods. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying, the student studies the losses occurring. The laboratory is so arranged that a student learns to handle a large amount of work with the best utilization of his time and with the accuracy demanded by best practice.

804. FIRE ASSAYING. *Laboratory.*

Sophomore year, second term, three hours per week.
Elective in VII (801).
Professor Clayton, Associate Professor Bains, Mr. Updike.

Covers more briefly the work outlined in course 802.

805. INTRODUCTORY METALLURGY.
Lectures and Laboratory.

Junior year, first term, one recitation hour and three laboratory hours per week.
Curriculum II (801, 802).
Professor Clayton.

This course will be given for the students in the Metallurgy curriculum and will serve as an introduction to general metallurgical practice. The work in the laboratory will teach the student the practice of sampling, leaching, fuel testing, temperature measuring, etc. In the classroom verbal and written reports will be made on all experiments.

807. PRINCIPLES OF METALLURGY. *Lectures.*

Junior year, second term, three hours per week.
Curricula I and II (503, 801, 802, 1002, 1003).
Texts: Fulton, *Principles of Metallurgy.*
Hoffman, *General Metallurgy.*

Professor Clayton.

This course is an introduction for the advanced metallurgical courses. The work is covered in a general way by the following headings: The properties of metals; the chemical equation from the standpoint of the metallurgist; methods of combustion; the temperature of combustion in any system and the effect thereon of certain variables; measurement of high temperatures; means of supplying oxygen for combustion, including stack design; metallurgical fuels and methods of firing, including a study of coals, coke, charcoal, gases from producers, and liquid fuels; calorimetry; refractories and their uses, types of furnaces and the reasoning involved in their design; a general study of typical metallurgical operations, including pyrometallurgical, hydrometallurgical and electrometallurgical processes; slags in general; conduction, radiation, and convection from the standpoint of the metallurgist. In this course much attention is given to the methods of attacking various metallurgical problems.

808. PRINCIPLES OF METALLURGY. *Laboratory.*

Senior year, first term, three hours per week.
Curriculum I (801, 802, 807).

Professor Clayton, Mr. Updike.

Application of the principles discussed in course 807.

809. METALLURGY OF IRON AND STEEL.
Lectures and Laboratory.

Junior year, second term, three lectures and three laboratory hours per week.

Curriculum II (807).
Texts: Stoughton, *Metallurgy of Iron and Steel.*
Howe, *Metallurgy of Cast Iron and Steel.*
Richards, *Metallurgical Calculation.*

Professor Clayton.

Intended primarily for those following metallurgy. A detailed study of iron and steel, production, thermal treatment and metallography.

810. METALLURGICAL CALCULATIONS. *Laboratory.*

Junior year, second term, three hours per week.
Curriculum II (to accompany 807).

Professor Clayton, Mr. Updike.

The problems given in this course are the common ones that the metallurgist meets in practice.

811. METALLURGY OF THE NON-FERROUS METALS. *Lectures.*

Senior year, first term, four hours per week.
Curriculum II (807).

Professor Clayton.

The greater part of the time is devoted to the metallurgy of copper, zinc, lead, gold and silver; but consideration is also given to tin, antimony and aluminum.

812. METALLURGY OF THE NON-FERROUS METALS. *Laboratory.*

Senior year, first term, three hours per week.
Elective (807 and 808, or 805 and 811).

Professor Clayton.

Aims not only to show the practical application of the principles outlined in course 811, but also to prove the statement that "Each ore is a problem in itself."

813. METALLURGY OF THE NON-FERROUS METALS. *Lectures.*

Senior year, second term, four hours per week.
Curriculum II (807, 811).

Professor Clayton, Associate Professor Bains.

A continuation of course 811.

814. METALLURGY OF THE NON-FERROUS METALS. *Laboratory.*

Senior year, second term, three hours per week.
Elective (807, 811, 813).

Professor Clayton.

A continuation of course 812.

821. ELECTRO-METALLURGY. *Lectures.*

Senior year, second term, three hours per week.
Elective (807, 811, 1050, 1052).

Associate Professor Bains.

A study of all metallurgical operations in which electricity plays a part, either electrolytically or electrothermically. Efficiency calculations based on these processes are given.

822. ELECTRO-METALLURGY. *Laboratory.*

Senior year, second term, six hours per week.
Elective (807, 811 to accompany 821).

Associate Professor Bains.

831. ORE DRESSING. *Lectures.*

Senior year, first term, three hours per week.
Curricula I and II (807).

Mr. Thornberry.

The principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore-dressing appliances. The latter part of the course deals with the management of mills and with the adaptation of processes to the successful treatment of various ores.

832. ORE DRESSING. *Laboratory.*

Senior year, first term, three hours per week.
Curriculum I (to accompany 831).

Mr. Thornberry.

The student becomes familiar with the operations and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

833. ORE DRESSING. *Lectures.*

Senior year, second term, three hours per week.
Curriculum I (831, 832).

Mr. Thornberry.

A continuation of course 831.

834. ORE DRESSING. *Laboratory.*

Senior year, second term, three hours per week.
Curriculum I (to accompany 833).

Mr. Thornberry.

836. ORE DRESSING PROBLEMS. *Laboratory.*

Senior year, second term, six hours per week.
Elective (831, 832).

Associate Professor Bains, Mr. Thornberry.

The design of ore dressing machinery and plants. The course includes the determination of a practical process for treating a given ore, and the design for a mill for utilizing this process.

861. METALS IN ENGINEERING. *Lectures.*

First term, two hours per week.
Curricula III and V.

Mr. Updike.

A short course in metallography, devoted to the study of physical metallurgy, as it is important to the users of metals, engineers and constructors in general.

863. ALLOYS AND METALLOGRAPHY. *Lectures.*

Senior year, first term, two hours per week.
Curricula II and IV (807, 809).

Professor Clayton.

These lectures deal with the theoretical and practical considerations that influence the structures and properties of metals and alloys.

864. ALLOYS AND METALLOGRAPHY. *Laboratory.*

Senior year, first term, six hours per week.
Curricula II and IV (must accompany 863).

In addition to the usual microscopic examination of metals, this course includes the use of the X-ray in metallography.

Professor Clayton.

865. ALLOYS AND METALLOGRAPHY. *Lectures.*

Senior year, second term, two hours per week.
Curriculum II (863, 864).

Professor Clayton.

A continuation of course 863.

866. ALLOYS AND METALLOGRAPHY. *Laboratory.*

Senior year, second term, three hours per week.
Curriculum II (863, 864, 865).

Professor Clayton.

890. WORK IN PRACTICE.

Summer vacation following the Junior year.

Curriculum II.

To receive a degree in Metallurgy, a student (a) must have worked not less than eight weeks in some metallurgical industry or plant; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching, at some metallurgical plant designated by the head of the department; or (c) a regular supervised inspection trip may be taken in place of this practice work or observation, provided that such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

896. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Curriculum II (807, 809, 811, 813).

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to specifications which will be sent on request.

899. SENIOR TRIP.

Senior year, second term.

Curriculum II.

During the second term of the Senior year a two weeks' trip is taken either to the Joplin district, or to Flat River and other points in the southeast Missouri lead district, for the purpose of studying ore dressing, smelting, metallurgical and power plants in these districts.

MILITARY SCIENCE AND TACTICS

Captain Medding, First Lieutenant Wanamaker, Master Sergeants Scott and McKimmey.

The War Department maintains at the Missouri School of Mines an Engineer Unit of the Reserve Officers' Training Corps.

Military Science and Tactics is required of all physically fit Freshmen and Sophomores and may be elected by Juniors and Seniors. If a student joins the R. O. T. C., the War Department will furnish his equipment and commutation of uniforms at the rate of $30.00 for the first and third years and $6.00 for the second and fourth years of his enrollment. The student is required to advance the above amounts on registering, receiving the commutation as a refund later in the year. The student who fully completes the school year satisfies completely his financial obligation and is no further financially bound, although he is under the moral obligation to continue his uniform in service during the ensuing year in the institution if he remains a member of the R. O. T. C. After two years' service the uniform becomes the exclusive property of the student, and if he remains a member of the R. O. T. C. he is entitled to secure the benefits of the second full commutation allowed the third year for the purchase of a second uniform.

Students electing R. O. T. C. work must do so for two years at a time. The first election is for the two-years' basic course, after which, if the student is recommended for further training, he may elect the advanced course for the remainder of the college course. During the last two years, if he elects the advanced course and attends one of the Senior advanced camps described below, he receives commutation of subsistence amounting to about $12.00 a month.

The R. O. T. C. Unit at the Missouri School of Mines is organized as a battalion of two companies, and the cadet officers are selected, as far as possible, from the members of the two upper classes who have elected to take the advanced course.

Each year, upon completion of the advanced course, students qualified for commissions in the Officers' Reserve Corps are selected by the Director of the School and the Professor of Military Science and Tactics. The President of the United States, under such regulations as he may prescribe, is authorized to appoint these men as reserve officers of the Army of the United States.

TRAINING CAMPS.

One or more R. O. T. C. Engineer Camps are held during the summer. They ordinarily open about the middle of June and continue for a period of six weeks. In the summer of 1921 this camp was held at Camp A. A. Humphreys, Va.

The Senior basic camp is attended normally at the end of the first year of the basic course and attendance is voluntary on the part of the student. The Senior advanced camp is attended normally at the end of the first year of the advanced course (Junior year); but, under certain conditions, it may be attended at the end of the Sophomore or Senior year. Attendance at the advanced camp is compulsory for those students who elect the advanced course and receive commutation of subsistence.

Transportation, subsistence, uniforms, equipment and medical attendance are furnished members of the R. O. T. C. attending summer camps. In addition to these allowances, students are paid at the rate of $30.00 a month while attending advanced course camps. The period of instruction at camps is properly divided between training in the fundamental military subjects and training in the special technical subjects with which the military engineer is concerned.

COURSES.

The course as outlined has for its primary object the training of engineering students, so that, at the termination of their instruction, they will possess the following essential characteristics of a well-balanced junior officer of Engineers:

(a) A good general education.
(b) A good engineering education.
(c) A well disciplined body and mind.
(d) A basic military training and a knowledge of the practical application of engineering principles and methods to military operations.

The first two characteristics are attained by following the regular college courses. The attainment of the third characteristic is reached by a combination of training on the drill field, in the lecture room and gymnasium, and at the training camps. The fourth is attained by instruction in those phases of military education and training which are fundamental and common to all arms, as well as those of a technical nature which pertain primarily to engineering in war.

The law requires a minimum average of three hours per week per academic year for military training during the basic course, and five hours per week during the advanced course if the student draws commutation. During two of these five hours the student is taking engineering courses of military value in departments other than that of Military Science and Tactics, so that the student actually spends three hours per week under the Department of Military Science and Tactics, throughout each of the four academic years.

In the military department the different subjects interlock and are arranged in accordance with the weather conditions. Therefore, the two terms are not segregated.

M 1 and M 2. MILITARY.

Freshman year, first and second terms, three hours per week.
Required in all curricula.

Captain Medding, Lieutenant Wanamaker,
Sergeants Scott and McKimmey.

Organization, discipline, military courtesy, customs of the service, military uniforms, insignia, colors; military hygiene; infantry drills, ceremonies, rifle marksmanship, gallery practice, physical exercises, security on the march and in camp, interior guard duty, field messages, visual signalling.

M 3 and M 4. MILITARY.

Sophomore year, first and second terms, three hours per week.
Required in all curricula (M 1, M 2).

Captain Medding, Lieutenant Wanamaker,
Sergeants Scott and McKimmey.

Organization; morale; voice training for commands, methods of instruction, infantry drills, ceremonies, rifle and pistol marksmanship, physical exercises; security on the march and in camp, interior guard duty, orders and reports; field fortifications; military bridges and roads; military map reading and map making; cordage and rigging.

M 5 and M 6. MILITARY.

Junior year, first and second terms, three hours per week.
Elective in all curricula (M 3, M 4).

Captain Medding, Lieutenant Wanamaker.

Morale, military hygiene, infantry drills, ceremonies, security, reconnaissance, minor tactics, military law, fortifications, camouflage, demolitions, military explosives, mine warfare, seacoast fortifications and their relation to the navy, military map making, road and position sketching, engineer organization.

M 7 and M 8. MILITARY.

Senior year, first and second terms, three hours per week. Elective in all curricula (M 5, M 6).

Captain Medding, Lieutenant Wanamaker.

Supply, customs of the service, infantry drills, ceremonies, hippology, courts martial, martial law, military government; The Corps of Engineers, its organization, staff relations, duties in peace and war, general construction, mechanical equipment and ordnance, artillery, projectiles, tanks, motor trucks, tractors, aircraft, searchlights, trench warfare material, landscape sketching, aerial photos, military history and policy, minor tactics to include the company.

MINING

PROFESSOR FORBES, ASSOCIATE PROFESSOR GUITERAS, MR. STROUP.

The mining lecture room is located on the first floor of Norwood Hall, in the southwest corner of the building. This room contains a number of mining exhibits, including mine models, several rock drills in section, rock drill bits, wire ropes, safety lamps, mine-rescue apparatus and various other mining appliances. A lantern and reflectoscope is provided in the class room and the department has several hundred slides of mining scenes and mining machinery.

A number of models illustrating mining methods, head frames, mine timbering, skip dumps, reversible mine fan and a rotary drill for coal mining, are on display in the mining laboratory, and are used in connection with the lecture work.

The surveying equipment, already referred to under Civil Engineering, includes a number of mining transits with auxiliary telescopes, which are used for field work in mine surveying.

LABORATORIES.

To meet the needs of some of the more important phases of mining work four laboratories have been equipped as follows:

Mine-Rescue and First-Aid Laboratory.—The equipment of this laboratory consists of three helmets, a Draeger, a Fleuss and a Westfalia, and all necessary first-aid supplies and charts.

The instruction in Mine-Rescue and First-Aid is given by representatives of the U. S. Bureau of Mines, from one of their mine-rescue cars.

Rock-Drilling Laboratory.—On account of the importance of rock drilling in metal mining, and also because it can readily be carried on in the laboratory, much stress is laid on this branch of the work. The drilling equipment consists of three piston drills and six hammer drills, including the mounted type or Water Leyner, the jack-hammer type and stopers.

For experimental work in drilling, large blocks of red granite are imported from southeast Missouri. For supporting the machines when mounted on columns, two drilling frames have been constructed. For drilling up-holes with the stopers, a concrete-lined pit has been excavated, over which is placed a large block of granite, supported on stringers.

For sharpening steel, besides the usual hand tools, there is a Leyner-Ingersoll 5A sharpener, with a complete assortment of dies and dollies for forming various-shaped bits, as well as parts for shanking Leyner, jack-hammer and piston steels.

The work done in this laboratory is largely experimental work, and includes investigations concerning rock-drill bits and drill steel and measuring air consumption of drills.

Compressed-Air Laboratory.—A Sullivan WB-2 straight-line air compressor of 290 cubic feet capacity, supplies air for this laboratory as well as for the rock-drilling laboratory.

Two large displacement tanks, 15 feet high and 5 feet in diameter, are used for making accurate measurements of air for the determination of orifice coefficients and for various other experiments. Another interesting installation in this laboratory is a mine fan. This is a 36-inch, single-inlet "Sirocco," directly connected to a 35-H. P. variable speed motor, and has a capacity of 20,000 cubic feet per minute, against a 4-inch water gauge. Two styles of runners, with vanes at different angles are provided for experimental work. The fan is used in the regular laboratory work, where its efficiency is determined under varying conditions, and also for experimental work in air measurements.

EXPERIMENTAL MINE.

In order to provide a laboratory where practical instruction in mining and mine surveying can be given, the school has equipped a small experimental mine. This mine is located about one and one-half miles from the school, at the site of an old dolomite quarry, where a tunnel has been driven into the hillside. The main tunnel is about 125 feet in length, 50 feet of which is timbered. Branch drifts have been run from each side of the tunnel, making a total of about 500 feet of underground openings. A small shaft about 25 feet deep, connects the main tunnel with the surface. A Joplin type of hoist, located in the head-frame over the shaft, is used to hoist the rock to surface where it is dumped into a small ore pocket. From the ore pocket the rock runs by gravity to a Blake crusher where it is crushed to 2 inches or smaller. From the crusher the rock runs to a belt-bucket elevator which hoists it into a 100 ton ore bin. Some of the rock is pulverized in a Jeffrey swing-hammer mill and is sold to the farmers in the vicinity for agricultural lime. The coarse rock from the Blake crusher is used for road and concrete work.

The power plant consists of a 125-H. P. return tubular boiler, an Imperial Type 10, Rand air-compressor of 100 cu. ft. capacity, a Laidlaw-Dunn-Gordon air compressor of 150 cu. ft. capacity, and a 35-H. P. Erie engine for running the crushing plant. Water for the boiler and drills is pumped from a nearby stream with a centrifugal pump, driven by a 3-H. P. Fairbanks-Morse gasoline engine.

The entire plant has all the elements of a mine and gives the student a much better opportunity to grasp the problems of mining while studying them in the classroom, than would otherwise be possible.

The laboratory work done at the experimental mine consists largely of drilling, blasting and mine surveying. In addition to this, some work is given in sharpening steel, timbering, mucking, track-laying, hand-drilling and running the power plant. This affords a greater variety of work than can ordinarily be obtained in a reasonable length of time in practice. It is not the aim in this work to make drill runners or miners out of students, but to give them a greater familiarity with mining tools and methods than is obtainable from books and mere observation.

COURSES.

900. MINE AND RAILROAD SURVEYING. *Lectures.*

Junior year, first term, three hours per week.
Curriculum I (102).
Text: Peele, *Mining Engineers' Handbook.*

Professor Forbes.

The theory and practice of mine surveying are presented by lectures. The methods of carrying azimuth underground are studied in detail, including shaft plumbing and the use of the auxiliary telescope. Problems involving the strike and dip of veins are introduced, including the determination of intersection of veins, length of tunnels to intersect veins at depth, and the determination of strike, dip and thickness of veins from bore hole data.

About one-third of the time is devoted to railroad surveying, studying the theory of simple, compound and reverse curves, frogs and switches, turnouts and cross-overs and earthwork.

901. MINE AND RAILROAD SURVEYING. *Laboratory.*

Junior year, first term, six hours per week.
Curriculum I (102 to be accompanied by 900).

Professor Forbes, Mr. Stroup.

In this course the original field notes of complete metal mine and coal mine surveys are given to the student, from which he works up the complete records for the mine office, including latitudes and departures and the finished mine maps.

Practical work in mine surveying at the school mine, is also a part of this course. Each student is required to make a complete survey of the experimental mine, plumbing the shaft with two wires and also using the auxiliary telescope. Complete notes of this survey, together with a map of the mine are required.

About one-fourth of the time is devoted to practice in railroad surveying.

903. MINING LABORATORY.

Junior year, first term, three hours per week.
Curriculum I (to be accompanied by 900, 901).

Professor Forbes.

Practical work in rock-drilling and blasting, timbering, sharpening steel, track-laying, mucking and operating of mine power plant. Written reports are required on all work. The course in Mine-Rescue Work, given by the United States Bureau of Mines is a required part of this laboratory.

904. MINING. *Lectures.*

Junior year, second term, four hours per week.
Curriculum I (903, 1002).
Texts: Peele, *Mining Engineers' Handbook.*
Current Technical Journals.
Publications of U. S. Bureau of Mines.

Professor Forbes.

A study of rock excavation, including rock drilling, explosives and blasting, supporting excavations, tunneling and shaft sinking, hoisting, haulage and ventilation.

906. MINING. *Lectures.*

Senior year, second term, four hours per week.
Curriculum I (904, 540).
Texts: Peele, *Mining Engineers' Handbook.*
Current Technical Journals.

Professor Forbes.

This course is a continuation of the work of the Junior year and includes the study of prospecting, sampling and estimation of ores, mine valuation, mining costs and mining methods. The principles of mining law are also reviewed.

Students taking the course who do not take Course 999, Senior Trip, will be given special work while the remainder of the class is taking the Senior Trip.

908. COAL MINING METHODS AND VENTILATION. *Lectures.*

Senior year, first term, four hours per week.
Curriculum (904, 1002).
Texts: Beard, *Mine Gases and Ventilation.*
Current Technical Journals.

Associate Professor Guiteras.

A detailed study of coal mining methods and ventilation. A large part of the course is devoted to problems in mine ventilation.

910. MINE AND MILL DESIGN. *Lectures and Laboratory.*

Senior year, first term, two hours lectures and six hours laboratory per week.
Curriculum I (604, 605).
Text: Ketchum, *Design of Mine Structures.*

Associate Professor Mann.

This course covers the graphic and analytic methods of determining stresses in the simpler engineering structures used in mining.

911. MINE AND MILL DESIGN. *Laboratory.*

Senior year, second term, six hours per week.
Curriculum I (910).

Associate Professor Guiteras.

This course is a continuation of course 910 and covers the complete design, with estimates and bills of materials, for the complete equipment of a given mine or mill.

912. PRINCIPLES OF MINING. *Lectures.*

Junior year, first term, three hours per week.
Elective (1002).
Text: Peele, *Mining Engineers' Handbook.*

Associate Professor Guiteras.

A special course in mining for metallurgists, designed to acquaint them with mining methods and conditions, so that they may be better fitted to co-operate with the mine management.

920. OIL PRODUCTION METHODS. *Lectures.*

Senior year, second term, three hours per week.
Curriculum I (1002).
Texts: Paine and Stroud, *Oil Production Methods.*
U. S. Bureau of Mines, *Bulletins*; *Technical Papers.*
Current Technical Journals.

Associate Professor Guiteras.

A study of well-drilling and oil-production methods.

921. OIL MAPPING AND GRAPHIC CHARTS. *Laboratory.*

Senior year, second term, three hours per week.
Elective (544). Mr. Woolrych.

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This is a drafting room course that includes a study of methods used by the large producing oil companies in their engineering and statistical departments. The work consists of making oil maps, graphic charts, and valuation curves.

990. WORK IN PRACTICE.

Summer vacation following Junior year.

Curriculum I.

To receive a degree in the mining course, the student (a) must have worked not less than eight weeks at some mine, mill or smelter, or have been engaged in geological or other work recognized as being along mining lines; or (b) if he is not able to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching at some mine or mill designated by the department; or (c) a regularly supervised inspection trip may be taken in place of this practice work or observation, provided such trip is offered by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

996. THESIS.

Senior year, either or both terms, at least six laboratory hours per week.

Elective.

Professor Forbes.

Senior students who show special aptitude may, with the approval of the head of the department, elect to carry on a special investigation and embody the results in a thesis. The subject of the thesis must be approved by the head of the department not later than the second week of the term in which the work is undertaken. The completed thesis must be filed with the head of the department not later than April 15th. All theses must conform to specifications which will be sent on request.

999. SENIOR TRIP.

Senior year, second term.

Curriculum I.

Professor Forbes, Associate Professor Guiteras.

During the second semester of the Senior year, a two-weeks' trip is taken either to the Joplin district, or to Flat River and other points in the southeast Missouri lead district, for the purpose of studying mining, ore dressing, smelting, and power plants in these districts. Students specializing in coal mining may visit the Illinois coal fields and those specializing in petroleum engineering may visit the Oklahoma oil fields, in place of taking the trip as above outlined.

PHYSICAL TRAINING

Associate Professor Dennie, Assistant Athletic Director McCune.

For the physical training of students excellent opportunities are offered by the Jackling Gymnasium and the Jackling Field. The former, completed in 1915, at a cost of seventy thousand dollars, is a strictly modern fire-proof building and is equipped with baths, dressing rooms, lockers, a swimming pool 20 feet wide and 60 feet long and various kinds of apparatus and game courts usually found in modern gymnasiums. Class work, consisting of setting-up exercises, developing exercises, calisthenics, the use of dumb-bells, clubs, and wands is given under the supervision of the Director of Physical Training. Instruction in swimming, boxing and wrestling is also given, the aim of this work being to develop health, strength, vitality and cohesion of movement.

Jackling Field, constructed in 1909, by virtue of a gift of Mr. D. C. Jackling, '92, adjoins the Gymnasium and provides a foot-ball gridiron, a baseball diamond, and a quarter-mile running track for class and intercollegiate games and events. A number of tennis courts about the campus are maintained in good order. Golf links near the campus are maintained for the benefit of the students.

The school encourages rational athletics and a participation in intra- and intercollegiate sport, all branches of which are under the direct supervision of the Director of Physical Training and management of the Board of Control. The membership of the Board of Control consists of the Director of Physical Training, the Chairman of the Faculty Committee on Athletics, the President and Student Manager of the Athletic Association, and the Secretary of the Executive Committee of the Board of Curators as ex officio treasurer.

The personnel of the Board of Control for 1921-22 comprises Professor Dennie, Professor Clayton, Mr. Zook, Mr. Updike and Mr. Kahlbaum.

Physical exercises in military drill and gymnasium are required of all physically fit Freshmen and Sophomores. A student who is physically unfit for military drill may, upon the advice of the Director of Student Health, substitute special work in the Gymnasium for the regular exercises.

During the first term, Freshman year, fifteen lectures in hygiene are given and one hour a week is devoted to setting-up exercises. During the second term, two hours a week are devoted to exercises with dumb-bells and chest weights.

During the Sophomore year two hours a week are devoted to exercises with wands, Indian clubs and chest weights, and to indoor games and apparatus work.

COURSES.

PE 1. PHYSICAL TRAINING.

Freshman year, first term, one hour per week.

Associate Professor Dennie.

All curricula.

A system of setting-up and developing exercises, the purpose of which is to build up and develop the muscular elements of the body and cohesion of bodily movement.

PE 2. PHYSICAL TRAINING.

Freshman year, second term, two hours per week.

Associate Professor Dennie.

All curricula.

A continuation of PE 2, to include the use of dumb-bells and military setting-up exercises.

PE 3. PHYSICAL TRAINING.

Sophomore year, first term, two hours per week.

All curricula.

Exercises with dumb-bells, bar-bells, wands, chest-weights and the playing of indoor and outdoor games with the object of making the student more active mentally and physically.

PE 4. PHYSICAL TRAINING.

Sophomore year, second term, 2 hours per week.

All curricula.

Continuation of PE 3.

PE 5. BOXING.

Open to all classes.

Instruction in elementary boxing and self-defence will include leads, blows, parries and defence. Shadow-boxing will be carried on until the students have mastered the art and then pairings will be made and men of similar weights will box with each other.

PE 6. SWIMMING.

Open to all classes.

Recognizing that ability to swim may often be of importance to the engineer, special attention is given to beginners, and all students are urged and encouraged to attain proficiency as early as possible in their school course.

PE 7. WRESTLING.

Open to all classes.

Purpose and general methods as in PE 5.

PHYSICS AND ELECTRICAL ENGINEERING

PROFESSOR WOODMAN, ASSOCIATE PROFESSOR FRAME, ASSISTANT PROFESSOR RATLIFF, ASSISTANT PROFESSOR LOVETT, M. W. WALLACE.

EQUIPMENT.

The Department of Physics and Electrical Engineering is located in Norwood Hall. The lecture room is in the southeast corner of the building on the first floor. On the same floor are found the office and recitation room used by the department. All of the laboratories are located in the basement of the building. The Physical Laboratory is a large, well-lighted room, and is well equipped with water and gas and suitable tables for carrying on nearly one hundred experiments especially chosen for engineering students.

The department is well equipped with apparatus for carrying on the work as it is outlined for engineering students. As the demand for courses in pure science increases, it is intended to increase the equipment so as to meet the needs and interests of these students.

The curriculum in Electrical Engineering is intended to give a foundation in the general principles upon which the development of electrical engineering practice depends. Co-ordinated with this instruction in general principles are courses of a more professional nature. A close relationship exists between classroom and laboratory work. The latter consists of a study of methods of electrical measurements and tests of instruments and machines of the usual types found in practice. Two laboratories are equipped with modern apparatus for this work—the Electrical Machinery Laboratory and the Electrical Measurements Laboratory. In the Electrical Machinery Laboratory are two large test benches provided with transfer panels so that connections may be readily made with any machine which is to be tested. The Electrical Measurements Laboratory is equipped with high grade apparatus for making standard electrical measurements. Transfer panels in these laboratories make it possible to connect any kind of power available with any circuit in either laboratory.

Another laboratory is being equipped for work in radio communication.

COURSES.

1000. GENERAL PHYSICS. *Lectures.*

Sophomore year, first term, four hours per week.
All curricula (must be preceded or accompanied by 602).
Text: Spinney, *A Textbook of Physics.*
Professor Woodman, Assistant Professor Ratliff.

This course includes the study of the mechanics of solids, liquids, and gases, and of heat, including an introduction to thermodynamics. Lectures, illustrated by experiments and recitations.

1001. GENERAL PHYSICS. *Laboratory.*

Sophomore year, first term, six hours per week.
All curricula (must be preceded or accompanied by 1000).
Professor Woodman, Assistant Professor Ratliff.

The laboratory is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of the relations between the quantities measured. Especial attention is given to the making of laboratory reports.

1002. GENERAL PHYSICS. *Lectures.*

Sophomore year, second term, four hours per week.
All curricula (must be preceded or accompanied by 603).
Text: Spinney, *A Textbook of Physics.*
Professor Woodman, Assistant Professor Ratliff.

The study of electricity and magnetism, sound, and light. Lectures, illustrated by experiments and recitations.

1003. GENERAL PHYSICS. *Laboratory.*

Sophomore year, second term, six hours per week.
All curricula (must be preceded or accompanied by 1002).
Professor Woodman, Assistant Professor Ratliff.

Deals with the subjects studied in course 1002 and the method is the same as that outlined in course 1001.

1010. ELECTRICITY AND MAGNETISM. *Lectures.*

Junior year, first term, three hours per week.
Elective (603, 1002, 1003).
Text: Starling, *Electricity and Magnetism.*
Professor Woodman.

Includes a mathematical discussion of fields of force, potential, capacity, resistance, and inductance. Emphasis is placed upon the solution of problems.

1011. ELECTRICITY AND MAGNETISM. *Laboratory.*

Junior year, first term, three hours per week.
Elective (must be preceded or accompanied by 1010).
Professor Woodman.

Includes the standard experiments in electrical measurements.

1012. LIGHT. *Lectures.*

Junior year, second term, three hours per week.
Elective (603, 1002, 1003).
Assistant Professor Ratliff.

An experimental and mathmematical discussion of reflection refraction, and polarization of light. There will be a discussion of spectroscopy and an introduction to the electromagnetic theory of light.

1013. LIGHT. *Laboratory.*

Junior year, second term, six hours per week.
Elective (must be preceded or accompanied by 1012).
Assistant Professor Ratliff.

Based on the work covered in course 1012.

1014. HEAT. *Lectures.*

Senior year, first term, three hours per week.
Elective (603, 1000, 1001).
Text: Edser, *Heat for Advanced Students.*
Assistant Professor Ratliff.

An experimental and mathematical discussion of thermometry; laws of gases; expansion of solids, liquids and gases; calorimetry; change of state; vapors; mechanical equivalent of heat; and a brief discussion of thermodynamics.

1015. HEAT. *Laboratory.*

Senior year, first term, three hours per week.
Elective (must be preceded or accompanied by 1014).
Assistant Professor Ratliff.

Based on the work covered in course 1014.

1016. RADIOACTIVITY. *Lectures.*

Senior year, second term, three hours per week.
Elective (1000, 1002).
Professor Woodman.

An historical and descriptive study of the radioactive processes.

1017. RADIOACTIVITY. *Laboratory.*

Senior year, second term, three hours per week.
Elective (must be preceded or accompanied by 1016).
Professor Woodman.

Opportunity will be given in the laboratory to repeat some of the simpler experiments with radioactive substances.

1025. ALTERNATING CURRENT THEORY. *Lectures.*

Senior year, first term, three hours per week.
Elective (603, 1050, 1052).
Professor Woodman.

Includes the mathematical theory of simple harmonic motion, the analysis of wave forms by means of Fourier's Series, a discussion of the circuit equations for both direct and alternating currents, and the elementary theory of the transformer.

1026. ALTERNATING CURRENT THEORY. *Lectures.*

Senior year, second term, three hours per week.
Elective (1025).
Professor Woodman.

A continuation of course 1025.

1030. RADIO COMMUNICATION. *Lectures and Laboratory.*

Senior year, second term, three lecture hours and three laboratory hours per week.
Elective (1052).
Text: Morecroft, *Principles of Radio Communication.*
Associate Professor Frame.

A discussion of the laws of oscillating circuits, and a study of transmitting and receiving systems for damped and undamped waves. Considerable time will be spent in the study of the action and theory of the three electrode vacuum tube on account of its importance in radio work.

1050. ELEMENTS OF ELECTRICAL ENGINEERING. *Lectures.*

Junior year, first term, three hours per week.
All curricula except IV (603, 1000, 1002).
Text: Dawes, *Electrical Engineering.*
Associate Professor Frame, Assistant Professor Lovett.

The fundamental laws of electric and magnetic circuits; laws of direct current circuits; laws of alternating current circuits having harmonic electromotive forces; and the principles of electrical systems and machines.

1051. ELEMENTS OF ELECTRICAL ENGINEERING.
Laboratory.

Junior year, first term, three hours per week.
All curricula except IV (must be preceded or accompanied by 1050).

Associate Professor Frame, Assistant Professor Lovett.

The calibration of instruments; the measurement of the magnetic properties of iron and steel; the measurement of resistance, current, potential, capacity and inductance; and the characteristic curves of dynamos and transformers.

1052. ELEMENTS OF ELECTRICAL ENGINEERING.
Lectures.

Junior year, second term, three hours per week.
Text: Dawes, *Electrical Engineering.*
All curricula except IV (1050, 1051).

Associate Professor Frame, Assistant Professor Lovett.

A continuation of course 1050.

1053. ELEMENTS OF ELECTRICAL ENGINEERING.
Laboratory.

Junior year, second term, three hours per week.
All curricula except IV (must be preceded or accompanied by 1052).

Associate Professor Frame, Assistant Professor Lovett.

A continuation of course 1051.

1054. ELECTRIC TRANSMISSION AND DISTRIBUTION.
Lectures and Laboratory.

Junior year, second term, three lecture hours and three laboratory hours per week.
Curriculum VI (1050, 1051).

Assistant Professor Lovett.

A study of the principles and practice governing the design, construction, and operation of long-distance transmission lines and overhead and underground distributing systems; plans and specifications of distribution and transmission systems; and the cost of production and distribution of power.

1055. ELECTRICAL MACHINERY. *Lectures.*

Senior year, first term, three hours per week.
Curricula V, VI (1050, 1052).

Associate Professor Frame.

A study of the various types of direct and alternating current machines with reference to their construction, operation, and uses in power work and industrial processes.

1056. ELECTRICAL MACHINERY. *Laboratory.*

Senior year, first term, three hours per week.
Curricula V, VI (must be preceded or accompanied by 1055).

Associate Professor Frame.

Laboratory practice in the construction, theory of operation, characteristics, efficiency, and heating of dynamos and transformers.

1057. ELECTRICAL MACHINERY. *Lectures.*

Senior year, second term, three hours per week.
Curricula V, VI (1055).

Associate Professor Frame.

A continuation of course 1055.

1058. ELECTRICAL MACHINERY. *Laboratory.*

Senior year, second term, three hours per week.
Curricula V, VI (must be preceded or accompanied by 1057).

Associate Professor Frame.

A continuation of course 1056.

1059. POWER STATIONS. *Lectures and Laboratory.*

Senior year, first term, three lecture hours and three laboratory hours per week.
Curriculum VI (1050, 1052).

Assistant Professor Lovett.

A study of the electrical equipment and the principles governing the operation of central power plants and substations.

1060. ELECTRIC RAILWAYS. *Lectures and Laboratory.*

Senior year, second term, three lecture hours and three laboratory hours per week.
Curriculum VI (1052, 1053, 1054).

Assistant Professor Lovett.

A study of the railway motor and auxiliaries; control of railway motors; train performance curves; signal service; track construction; electric locomotives, and commercial tests on standard machines.

1090. WORK IN PRACTICE.

Summer vacation following the Junior year.

Required in Curriculum VI.

To receive a degree in Electrical Engineering, the student (a) must have worked not less than eight weeks in some electrical engineering plant or industry; or (b) if he is unable to fulfill this requirement, he may spend not less than four weeks in observation, note-taking and sketching at some electrical plant designated by the department. Suitable reports and satisfactory credentials are required on all this prescribed work, which should be done during the summer following the Junior year, if possible.

1096. THESIS AND DESIGN. *Laboratory.*

Senior year, second term, twelve hours per week.

Curriculum VI (1052, 1053).

Professor Woodman, Associate Professor Frame, Assistant Professor Lovett.

Each student is assigned a problem which will require original thought and investigation. He is expected to submit a complete report of his work, including the experimental processes involved, and the design of any special equipment or apparatus required in the solution of the problem. Such report must be filed with the head of the department not later than April 15th, and must conform to specifications for theses which will be sent on request.

VOCATIONAL DEPARTMENT

U. S. VETERANS' BUREAU

FACULTY

CHARLES EDWARD COOKE,
Professor of Topographic Engineering, Head of Department of Vocational Education.

HARVEY ODEN GARST,
Professor of Highway Engineering.

CLARENCE EDWARD BARDSLEY
Assistant Professor of Topographic Engineering.

STERLING PRICE BRADLEY,
Assistant Professor of English.

VICTOR KOPPLE FISCHLOWITZ,
Instructor in Mathematics.

EDMUND HUGH WOOLRYCH,
Instructor in Oil-Field Engineering.

CHARLES GORDON COOKE,
Instructor in Topographic Engineering.

THADDEUS THORNDIKE RANNEY
Instructor in Topographic Engineering.

WILLARD BARTLETT BREWER,
Instructor in Topographic Engineering.

WALTER CHARLES ZEUCH,
Instructor in Highway Engineering.

ERNEST ETHERAGE DECKER,
Assistant in Topographic Engineering.

CELESTINE PIERRE CAMBIAIRE,
Instructor in Spanish.

EARL McKINLEY GUY,
Student Instructor in Mathematics.

JOHN GAINES MILLER,
Student Instructor in Mathematics.

HOMER LAKIRBY LEONARD,
Student Instructor in Mathematics.

BEN McCOLLOCH LAYTON,
Student Instructor in Mathematics.

WILLIAM ORVAL KEELING,
Student Instructor in Mathematics.

HARRY SIMANTON PENCE,
Student Instructor in Mathematics.

DANIEL BOONE JETT,
Student Instructor in Mathematics.

JOSEPH WORLEY,
Student Instructor in Mathematics.

KURT HERMAN deCOUSSER,
Student Instructor in Mathematics.

CHARLES BAYARD KALEY,
Student Assistant in Highway Engineering.

WILLIAM RAY DENISON,
Student Assistant in Highway Engineering.

EDWARD JAMES TORRENCE,
Student Instructor in English.

FRANCIS KINLOCH MIDDLETON HUNTER,
Student Assistant in English.

ALFRED ARTHUR BOYLE,
Student Assistant in Drawing.

HAROLD ROBERT POWERS,
Student Assistant in Drawing.

ISAAC FRANKLIN HODGES,
Student Instructor in Surveying.

WILLIAM WEEKS BOLT,
Student Assistant in Geology.

HARRY HERBERT HUGHES, JR.
Chief Clerk.

HOWARD JONES TEAS,
Coordinator.

ADA SANDER,
Stenographer.

MRS. ANTHONY MEGLITSCH,
Stenographer.

VOCATIONAL EDUCATION.

COURSE VIII.

A—TOPOGRAPHIC ENGINEERING.

Department.	No.	Course.	Hours per week. Lect.	Hours per week. Lab.
Vocational	1100	Topographic Engineering	3	0
Vocational	1101	Topographic Office Practice	0	6
Vocational	1102	Topographic Field Practice	0	35
Vocational	1103	Geodetic Computations	2	0
Vocational	1104	Geodetic Computations	0	6
Vocational	1105	Physiography	2	0
Vocational	1106	Topographic Map Interpretation	0	3
Vocational	1107	Elementary Geology	2	0
Vocational	1111	Elementary Drawing	0	6
Vocational	1136	*Practical Mathematics	3	0
Vocational	1137	*Plane Geometry	3	0
Vocational	1138	*Practical Algebra	3	0
Vocational	1139	*Advanced Algebra	3	0
Vocational	1140	*Practical Trigonometry	3	0
Vocational	1141	*Advanced Trigonometry	3	0
Vocational	1142	*Elementary English	5	0
Vocational	1143	*Advanced English	5	0

B—HIGHWAY ENGINEERING.

		First Year:		
Vocational	1108	Roads and Pavements	3	0
Vocational	1109	Road and Bridge Laws	2	0
Vocational	1110	Plane Surveying	2	9
Vocational	1111	Elementary Drawing	0	6
Vocational	1112	Road Construction	3	0
Vocational	1113	Practical Highway Problems	2	3
Vocational	1114	Highway Mapping	0	6
Vocational	1115	Materials Testing	0	6
Vocational	1116	Practical Highway Computations	2	0
Vocational	1117	Maintenance of Roads	3	0
Vocational	1118	Road Surveys	0	15
Vocational	1136	*Practical Mathematics	3	0
Vocational	1137	*Plane Geometry	3	0
Vocational	1138	*Practical Algebra	3	0
Vocational	1142	Elementary English	5	0

*The student will be assigned to courses in Mathematics and English listed above according to his previous training. The student will not find it advisable to pursue more than two of the courses offered in Mathematics and one of the courses offered in English.

B. HIGHWAY ENGINEERING—Continued.

Department.	No.	Course.	Hours per week. Lect.	Hours per week. Lab.
		Second Year:		
Vocational.....	1119	Equipment and Organization.......	3	0
Vocational.....	1120	Drainage........................	2	3
Vocational.....	1121	Gravel Pits and Quarries..........	0	3
Vocational.....	1122	Relocation......................	0	6
Vocational.....	1123	Cost and Accounting..............	2	0
Vocational.....	1124	Concrete in Road Construction.....	2	0
Vocational.....	1125	Contracts.......................	2	0
Vocational.....	1126	Road Plans......................	0	6
Vocational.....	1127	Culvert Design..................	0	6
Vocational.....	1128	Tractors and Gas Engines.........	2	3
Vocational.....	1129	Estimates.......................	3	12
Vocational.....	1139	*Advanced Algebra...............	3	0
Vocational.....	1140	*Practical Trigonometry..........	3	0
Vocational.....	1141	*Advanced Trigonometry..........	3	0
Vocational.....	1143	Advanced English................	5	0

C—OIL FIELD ENGINEERING

Vocational.....	1130	Oil Engineering Drafting..........	0	7
Vocational.....	1131	Graphic Presentation of Oil Statistics	0	6
Vocational.....	1132	Valuation of Oil Properties.........	0	3
Vocational.....	1133	Oil Production Methods...........	3	0
Vocational.....	1134	Abstract of Land Laws............	3	0
Vocational.....	1135	Elementary Surveying............	0	3
Vocational.....	1105	Physiography....................	2	0
Vocational.....	1106	Topographic Map Interpretation....	0	3
Vocational.....	1107	Elementary Geology..............	2	0
Vocational.....	1111	Elementary Drawing..............	0	6
Vocational.....	1136	*Practical Mathematics...........	3	0
Vocational.....	1137	*Plane Geometry.................	3	0
Vocational.....	1138	*Practical Algebra...............	3	0
Vocational.....	1139	*Advanced Algebra...............	3	0
Vocational.....	1140	*Practical Trigonometry..........	3	0
Vocational.....	1141	*Advanced Trigonometry..........	3	0
Vocational.....	1142	*Elementary English..............	5	0
Vocational.....	1143	*Advanced English................	5	0

*The student will be assigned to courses in Mathematics and English listed above according to his previous training. The student will not find it advisable to pursue more than two of the courses offered in Mathematics and one of the courses offered in English.

VOCATIONAL EDUCATION

The Veterans' Bureau, Division of Rehabilitation, sends ex-soldiers to the School of Mines for training. Some of these students are qualified to enter the regular courses given by the School; the remainder, because of their previous lack of training, are given special instruction to prepare them to fill remunerative positions.

These special courses include topographic engineering, highway engineering, and oil-field engineering. Though the greater part of the student's time is devoted to these special courses, a part of it is given up to mathematics and English, in order that he may become better grounded in these subjects.

TOPOGRAPHIC ENGINEERING.

It is expected that the students taking topographic engineering will, after two years intensive training, be prepared for the duties of junior topographer and will be eligible for appointment under the United States Civil Service rules to positions in the United States Geological Survey. This course includes lecture and classroom exercises and field work. Standard equipment is available for each branch of the work, a part of which has been obtained from the U. S. Geological Survey. At the expiration of his training the student will have acquired the theory and a working knowledge of the various phases of the subject.

The principal subjects included in this course are triangulation, primary traverse, leveling, map projections, plane table work, contour construction, map drawing, and map reproduction. For a thorough understanding of these subjects, a more or less intimate knowledge of a variety of related subjects, such as geodesy, astronomy, terrestrial magnetism, geology, and physiography is to be acquired.

1100. TOPOGRAPHICAL ENGINEERING. *Lectures.*
December 1 to March 31, sixteen weeks, 3 hours a week.
Course VIII.
Text: *Manuscript Notes.* Professor Cooke.

The figure of the earth and its dimensions, results of meridian-arc measurements and pendulum observations, precise measurements and their reduction to the spheroid, meridian and latitude determinations by observations on the sun and stars, relations of sideral, solar, and standard times, the earth's magnetism and its effects on the behavior of the compass, charting of the isogons and periodic changes in magnetic values, and a thorough expose of the fundamentals of topographic engineering.

1101. TOPOGRAPHIC OFFICE PRACTICE. *Laboratory.*

December 1 to March 31, sixteen weeks, 6 hours a week.

Course VIII (1100).

Text: *U. S. Geological Survey, Topographic Instructions.*

Professor Cooke.

The student will be thoroughly drilled in the making of tracings, the enlargement and reduction of map, right line drawing, free hand lettering, conventional signs, map projections, plotting of geodetic coordinates; in short, every phase of the construction of a topographic map.

1102. TOPOGRAPHIC FIELD PRACTICE. *Laboratory.*

April 1 to November 30, thirty-two weeks, 35 hours a week.

Course VIII (1100, 1101).

Professor Cooke, Assistant Professor Bardsley, Mr. Ranney, Mr. Brewer, Mr. Cooke, Mr. Decker.

The student will be drilled in triangulation, primary traverse, leveling, plane table work, astronomic observations, adjustment and care of instruments, and general field methods.

1103. GEODETIC COMPUTATIONS. *Lectures.*

December 1 to March 31, sixteen weeks, 2 hours a week.

Course VIII (Trigonometry).

Text: *Manuscript Notes.*

Assistant Professor Bardsley.

Computations of the results of triangulation, including reduction of base line measurements, tabulation of angles, reduction to center, correction for swing, computations of spherical excess, computation of the inverse solution, least square adjustment, computation of geodetic coordinates, and computation of "three-point" problem. Computation of the results of primary traverse, including computation of deflection angles; computation of latitude and longitude, computation of diagonals, computations of astronomic observations, computation of surveys of equal precision such as highway and railroad surveys, adjustment of traverse lines and level nets.

1104. GEODETIC COMPUTATIONS. *Laboratory.*

December 1 to March 31, sixteen weeks, 6 hours a week.
Course VIII (1102, 1103).
Text: *Standard Forms and Tables.*
Assistant Professor Bardsley.

This course is intended to thoroughly acquaint the student with the different phases of the geodetic computations enumerated in Course 1103. Results of actual field surveys, including primary traverse and triangulation as outlined in Course 1102, will be computed. The tables and formulas, such as Vega, Logarithms, Gurden, Traverse tables, the Ephemeris, Barlow's tables of squares and roots, and Geographic tables and formulas (U. S. Geological Survey, Bulletin 650). In this work U. S. Geological Survey forms and methods will be used.

1105. PHYSIOGRAPHY. *Lectures.*

December 1 to March 31, sixteen weeks, 2 hours a week.
Course VIII.
Text: Hopkins, *Elements of Physical Geography.*
Assistant Professor Bardsley.

A study of the features of the earth and of the physiographic processes which have wrought the changes in the surface forms. This subject is designed as an aid to the proper delineation of these features on topographic maps.

1106. TOPOGRAPHIC MAP INTERPRETATION. *Laboratory.*

December 1 to March 31, sixteen weeks, 3 hours a week.
Course VIII (1105).
Text: U. S. Geological Survey, *Quadrangles.*
Professor Cooke.

This is a course in the interpretation of topographic maps and is given in conjunction with Course 1105.

1107. ELEMENTARY GEOLOGY. *Lectures.*

December 1 to March 31, sixteen weeks, 2 hours a week.
Course VIII (1105).
Text: Chamberlain and Salisbury, *Geology.*
Mr. Dunlop.

This course is intended to supplement Course 1105 and deals with typical geologic structures and their effects on the physiographic development of the earth's surface.

HIGHWAY ENGINEERING.

Probably no other field of endeavor is now afforded greater opportunities for employment and advancement than highway engineering. While highway improvement in the United States may still be regarded in its infancy, yet we have already made phenomenal strides in this direction. Though it has been only a very few years since either the states or the federal government made their first meager appropriations toward general road improvement, we find today townships, special road districts, counties and states in seeming competition with each other as to which can raise the largest funds for road improvement and an effort on the part of the government to extend federal aid to each of the several states in proportion to the amount of funds raised within the states. With the increasing expenditure of public funds on our roads there is coming a realization on the part of the public that these expenditures should be intelligently directed. The demand for highway engineers, foremen, superintendents and inspectors is universal and the field is everywhere. The work is so broad in its scope that the individual engineer may find employment to his liking whether he prefers office work or field work, location and design, or construction.

The described course is designed to meet the requirements of men who have not had the advantage of secondary education and who have a limited time in which to get special training. It is highly specialized and practical. The course covers a period of two years, six months of which are devoted to placement training.

1108. ROADS AND PAVEMENTS. *Lectures.*

First year, September 1 to November 30, 12 weeks, three hours a week.

Course VIII.

Texts: Agg. *Construction of Roads and Pavements.*
Manuscript Notes.
Library References.

Professor Garst.

This course is designed to give the student a general insight into the fundamental principles of road construction and maintenance and to acquaint him with the various types of construction. The advantages of different types of roads and pavements under various conditions of climate and traffic will be discussed and considered together with a general comparison of costs.

1109. ROAD AND BRIDGE LAWS. *Lectures.*

First year, September 1 to November 30, 12 weeks, two hours a week.

Course VIII.

Texts: *Manuscript Notes.*
State Compilations of Road Laws.

Professor Garst.

The object of this course is to give the student a general knowledge of highway administration. The course is outlined from official compilations of the Road and Bridge Laws of some of the leading good road states. It sets forth the organization of state highway departments, the raising of road funds by bond issues or otherwise, the letting of contracts and the duties and responsiblities of engineers in matters concerning public roads and bridges.

1110. PLANE SURVEYING. *Lectures and Laboratory.*

First year, September 1 to November 30, 12 weeks, two lecture hours and nine laboratory hours a week.

Course VIII.

Text: Pence and Ketchum, *Surveying Manual.*

Mr. Zeuch.

The aim of this course is to give the student a knowledge of the theory and practice of plane surveying including the use of the transit, level, hand level and engineer's chain, together with notes and computations used in highway engineering. The laboratory work consists of two afternoons per week devoted to field practice and one afternoon per week to the correction and revision of field notes and to the solution of field problems. The field practice consists of exercises in chaining, leveling, cross sectioning, tracing a grade with hand level and the simpler transit problems such as the prolongation of straight lines, intersection of lines, reading of vernier and magnetic needle, deflection angles, computation of bearings and checking of computed bearing by magnetic needle. The field practice is conducted on a triangulation system specially laid out for the use of vocational students as a means of checking the accuracy of the work performed.

1111. ELEMENTARY DRAWING. *Laboratory.*

First year, September 1 to November 30, 12 weeks, six hours a week

Course VIII.

Text: *Manuscript Notes.* Mr. Woolrych.

This course consists of exercises in lettering and the principal geometric constructions. It is designed to make the student familiar with the use of the drawing instruments and at the same time to give such exercises as to best prepare him for following courses.

1112. ROAD CONSTRUCTION. *Lectures.*

First year, December 1 to February 28, 12 weeks, three hours a week.

Course VIII (1108).

Texts: Agg, *Construction of Roads and Pavements.*
Harger and Bonney, *Highway Engineer's Handbook.*
Manuscript Notes.

Professor Garst.

A continuation of (1108) with more attention given to the details of construction methods and less attention given to the discussion of types and the characteristics of different types.

1113. PRACTICAL HIGHWAY PROBLEMS.
Lectures and Laboratory.

First year, December 1 to February 28, 12 weeks, two lecture hours and three laboratory hours a week.

COURSE VIII.

Texts: Harger and Bonney, *Highway Engineer's Handbook.*
Pence and Ketchum, *Surveying Manual.*

Mr. Zeuch.

The object of this course is to give the student a thorough knowledge of the usual transit and level problems encountered in the field. Especial attention will be given to computation of curves by the use of the tables of functions of one-degree curves. The laboratory period, one afternoon of three hours per week, will be devoted to exercises in the drafting room where the student will be required to solve problems discussed in the lectures and reduce his work to the standard forms of engineering notes.

1114. HIGHWAY MAPPING. *Laboratory.*

First year, December 1 to February 28, 12 weeks, six hours a week.

COURSE VIII.

Text: *Field Notes of Actual Surveys.*

Mr. Zeuch, Mr. Denison.

The student will be required to plat alignment, profile and cross-sections of road plans from field notes. The specifications of the U. S. Bureau of Public Roads will be followed in making these maps.

1115. MATERIAL TESTING. *Laboratory.*

First year, December 1 to February 28, 12 weeks, six hours a week.

Course VIII.

Texts: Hatt and Scofield, *Laboratory Manual of Testing Materials.*
Manuscript Notes.

Professor Garst, Mr. Kaley.

Practical elementary tests of road materials such as mechanical analysis of sand, gravel, broken-stone, slag or mixtures of same; abrasion and toughness tests of stone, gravel, brick, etc., the determination of weight per cubic foot, specific gravity and water absorption of various road materials; elutriation tests of sand or other fine aggregate; tests for determining plasticity and slacking properties of clays and some of the simpler tests of bituminous materials. This course should fit the interested and capable men for placement training in testing laboratories, thus opening up to them a remunerative and desirable field of work.

1116. PRACTICAL HIGHWAY COMPUTATIONS. *Lectures.*

First year, March 1 to May 31, 12 weeks, two hours a week.

Course VIII (1113).

Texts: Pence and Ketchum, *Surveying Manual.*
Harger and Bonney, *Highway Engineer's Handbook.*

Mr. Zeuch.

Continuation of course (1113) introducing grade lines and computation of quantities. The establishment of economical grade lines within the desired limits is a consideration of almost as much importance as proper location and drainage, and of quite as much difficulty of understanding. The lectures will be followed up by problems especially adapted to give the student an understanding of this feature of highway design.

1117. MAINTENANCE OF ROADS. *Lectures.*

First year, March 1 to May 31, 12 weeks, three hours a week.

Course VIII (1108 and 1112).

Texts: Agg, *Construction of Roads and Pavements.*
Harger and Bonney, *Highway Engineer's Handbook.*
Publications of the U. S. Bureau of Public Roads.
Manuscript Notes.

Professor Garst.

Maintenance of different types of roads will be studied and methods of best practice under varying conditions of traffic and climate will be outlined and discussed.

1118. ROAD SURVEYS. *Laboratory.*

First year, March 1 to May 30, 12 weeks, fifteen hours a week.
Course VIII (1110 and 1114).
Texts: Pence and Ketchum, *Surveying Manual.*
Harger and Bonney, *Highway Engineer's Handbook.*
Mr. Zeuch, Mr. Denison.

The object of this course is to teach the students the methods of best practice in the making of road surveys and the best forms of notes for recording same. It will at the same time give him further practice in the use of engineering instruments. Students will be required to run transit location line for proposed road, sketch topography, run levels and take the necessary cross-sections. The notes taken in the field will be platted in the drafting room. A grade line will be sketched on the profile and quantities computed, but balancing of quantities and the selection of economical grade lines will not be required in this course.

1119. EQUIPMENT AND ORGANIZATION. *Lectures.*

Second year, September 1 to November 30, 12 weeks, three hours a week.
Course VIII (1108, 1112 and 1117).
Texts: *Manuscript Notes.*
Library References.
Professor Garst.

This course will be taken up with a consideration of road construction from the standpoint of the foreman and contractor. Equipment and working organization will be compared and studied with respect to *efficiency in performing work.*

1120. DRAINAGE. *Lectures and Laboratory.*

Second year, September 1 to November 30, 12 weeks, two lecture hours and three laboratory hours a week.
Course VIII.
Texts: Harger, *Location, Grading and Drainage of Highways.*
Library References.
Professor Garst, Mr. Zeuch, Mr. Kaley.

This course will cover in detail the entire problem of drainage in road construction and maintenance. The laboratory periods will be used in making field excursions for the study of surface and subsurface drainage conditions on the roads adjacent to Rolla. Good and bad conditions will be pointed out to the students and remedies for bad conditions will be suggested. In this course the student will be required to estimate the size and general characteristics of small drainage areas for determination of size of culvert opening.

1121. GRAVEL PITS AND QUARRIES. *Laboratory.*

Second year, September 1 to November 30, 12 weeks, three hours a week.

Course VIII.

Text: *Manuscript Notes.* Professor Garst, Mr. Kaley.

On one afternoon each week the students will make excursions into the country to locate and sample deposits of gravel and other road materials. Students will be required to make field tests to determine the desirability of the material, the quantities available and the expense of stripping, mining and hauling. In making these field excursions as well as in making the excursions for the preceding course, any road matters of interest along the road will be observed and discussed.

1122. RELOCATIONS. *Laboratory.*

Second year, September 1 to November 30, 12 weeks, six hours a week.

COURSE VIII (1110, 1114 and 1118).

Texts: Pence and Ketchum, *Surveying Manual.*
Harger and Bonney, *Highway Engineer's Handbook.*
Professor Garst, Mr. Kaley.

Former exercises in road surveys were made for the purposes of affording the student a knowledge of the use of surveying instruments and the best practices and methods of making surveys and of keeping notes. In this course the student will be taught the fine points of road location with respect to best alignment and to the securing of proper drainage with minimum grades and least cost of construction.

1123. COST AND ACCOUNTING. *Lectures.*

Second year, December 1 to February 28, 12 weeks, two hours a week.

Course VIII.

Text: *Manuscript Notes.* Professor Garst.

This course will comprise the collection of comparative cost data as well as an analysis of the cost of road construction and maintenance so as to enable the student to keep records of costs of work under his supervision and how to use cost data in making estimate of proposed work.

1124. CONCRETE IN ROAD CONSTRUCTION. *Lectures.*

Second year, December 1 to February 28, 12 weeks, two hours a week.

Course VIII (1108, 1112 and 1119).

Texts: *Bulletins U. S. Bureau of Public Roads.*
Trade Publications.
Library References and Manuscript Notes.
Professor Garst.

The ever increasing use of concrete for many purposes in highway construction warrants special consideration of this subject. The aim will be to make the course thoroughly practical. Field methods of proportioning, mixing, placing and curing under various conditions will be fully discussed. The design of concrete pavement, concrete sub-base, retaining walls and small culverts will be studied through a consideration of well proven and typical standard designs. No attempt will be made to go into the theory of concrete design.

1125. CONTRACTS. *Lectures.*

Second year, December 1 to February 28, 12 weeks, two hours a week.

Course VIII.

Texts: Tucker, *Contracts in Engineering.*
Manuscript Notes. Professor Garst.

This course is intended to acquaint the student with the forms and interpretation of engineering contracts and specifications and give him a general knowledge of business and commercial law which will be of value in any field of life.

1126. ROAD PLANS. *Laboratory.*

Second year, December 1 to February 28, 12 weeks, six hours a week.

Course VIII (1122). Professor Garst, Mr. Kaley.

A study of the more intricate problems of grade design and the balancing of cut and fill quantities to eliminate excessive overhaul costs. This course will comprise all the office work corresponding to course (1122).

1127. CULVERT DESIGN. *Laboratory.*

Second year, December 1 to February 28, 12 weeks, six hours a week.

Course VIII (1124). Professor Garst, Mr. Kaley.

Two afternoons per week in the drafting room will be devoted to copying standard plans of small bridges and culverts, making estimates of costs and quantities of same. The object will be to impress on the minds of the students a few examples of good practice and to give them some plans of their own work to carry away with them.

1128. TRACTORS AND GAS ENGINES.
Lectures and Laboratory.

Second year, March 1 to May 31, 12 weeks, two lecture hours and three laboratory hours a week.

Course VIII.

Text: Wright, *Automotive Repair.*
Professor Garst, Mr. Denison.

This course is intended to give the student a practical working knowledge of the operation of gas engines and tractors which will enable him as foreman or engineer in charge of force account to use his equipment efficiently and in case of engine trouble or slight break-downs to be able to make adjustment or repairs so that the work may not be delayed. Special attention will be given to lubrication, ignition and adjustment of the carbureter.

1129. ESTIMATES. *Lectures and Laboratory.*

Second year, March 1 to May 31, 12 weeks, three lecture hours and twelve laboratory hours a week.

Course VIII (1110, 1114, 1118, 1122 and 1127).

Text: *Manuscript Notes.* Professor Garst, Mr. Kaley.

The lectures will cover a general field, including preliminary estimates based on reconnaissance, estimates based on final approved plans, monthly progress estimates and final completion estimate of a project. The laboratory periods will be divided between field work and exercises in the drafting room. The students will be required to make reconnaissance surveys of a few miles of road adjacent to Rolla and work up preliminary estimate from same in the drafting room. The drafting room exercises will cover the whole field of estimates as outlined in the lectures.

In order to give the student some practical experience under actual working conditions, arrangements are being made with state highway departments for the employment of students on construction work during the months of June, July and August. Without discounting the importance to the engineer of his school work, the fact remains that there are many important things in the engineer's education which he must learn by experience in the field of actual practice rather than in the classroom. Men who have been good students in school sometimes make a failure of the first work assigned to them because of the lack of a practical conception of their work. First failures often seriously delay one's success. Our placement training course is intended to give the men practical conception of their work which will help them to make a success in their chosen work from the very start. While it will be a restful change from the steady grind of school work, yet it is not to be regarded as a vacation.

Students will be assigned to the larger construction jobs where they will have the opportunity to observe and assist in supervising practically all phases of highway construction such as clearing and grubbing, rough grading, finishing, construction of bridges and culverts, and the various types of surfacing such as gravel, macadam and concrete. In our two year highway course we will devote two terms of three months each to placement training. The student will not be a mere observer, but will be required to actively assist the engineer to whom he is assigned.

OIL FIELD ENGINEERING.

The oil industry has become a very important one. The demand for oil products is increasing yearly. From time to time new fields are discovered and the search for new territory is constantly going on. Naturally the growth of the industry and the demand for trained men go hand in hand, and this special course is designed to prepare men for technical positions in places where there is a demand for their services and the emoluments are attractive.

1130. OIL ENGINEERING DRAFTING. *Laboratory.*

Offered every semester, sixteen weeks, seven hours a week.
Course VIII.
Texts: French, *Engineering Drawing.*
Lessee Maps.

Mr. Woolrych.

Compiling county maps, showing legal surveys, ownership and well locations; special oil pool maps showing operating companies, oil wells, dry holes, pipe lines, etc., making scout territory maps, using colors, likewise lessee's territory maps; drawing lease charts from the oil lease; figuring acreage; checking maps from scout reports.

1131. GRAPHIC PRESENTATION OF OIL STATISTICS. *Laboratory.*

Offered every semester, sixteen weeks, six hours a week.
Course VIII.
Text: *Manuscript Notes.*

Mr. Woolrych.

This course consists of general principles pertaining to the use of charts; organization of charts; cost analysis of charts; rectilinear column; bar and circle charts; gathering of data for permanent records of wells, leases and oil pool ; sources of information.

1132. VALUATION OF OIL PROPERTIES. *Laboratory.*

Offered every semester, sixteen weeks, three hours a week.
Course VIII.
Texts: U. S. Bureau of Mines, *Bulletins.*
Manuscript Notes and Maps. Mr. Woolrych.

Expected performance estimated from past performance of wells, leases and fields; items of cost entering into the development of oil properties; plotting curves to judge ultimate future production of wells, leases, or fields, etc.

1133. OIL PRODUCTION METHODS. *Lectures.*

Offered every semester, sixteen weeks, three hours a week.
Course VIII.
Texts: Johnson and Huntley, *Oil and Gas Production.*
U. S. Bureau of Mines, *Bulletins.*

Mr. Woolrych.

The various systems of drilling wells and producing oil are taken up in detail; also showing comparative costs and drilling time of the different drilling systems. This subject also includes the following: Methods of casing the well, keeping the log, how deep to drill, the fuel and water supply, "Bringing in the well," the management of oil wells and producing properties.

1134. ABSTRACTS AND LAND LAWS. *Lectures.*

Offered every semester, sixteen weeks, three hours a week.
Course VIII.
Texts: Robinson, *Elementary Law.*
Manuscript Notes.
Standard Legal Forms.

Mr. Woolrych.

A knowledge of land law or real property is very helpful to all oil men and especially necessary to leasemen and scouts who wish to advance. This subject has been arranged so that the important deeds and other legal forms pertaining to buying and leasing land have been included and described in full; also, the kinds of titles, grants and patents, descriptions of land, analysis of deeds, kinds of conveyances, mortgages, etc.

1135. ELEMENTARY SURVEYING. *Laboratory.*

Offered every semester, sixteen weeks, three hours a week.
Course VIII.
Texts: Breed and Hosmer, *Elementary Surveying.*
Pence and Ketchum, *Surveying Manual.*

Mr. Hodges.

This course is intended to familiarize the student with the instruments used in surveying such as the transit, level, plane table, etc. The greater part of the time will be devoted to methods of land subdivision, making locations for oil wells, laying out oil leases, and other phases peculiar to the oil industry.

OIL FIELD TRIP.

The oil field engineering class, accompanied by the instructor, will take a short inspection trip to the Illinois oil field, visiting gas plants, gas wells, drilling and producing wells, and refineries.

PLACEMENT TRAINING.

Placement training in the western or southern oil fields will be arranged for the students so they can get actual experience in oil company methods of map making, scouting, leasing, surveying, office and field organizations. This training will probably take place during the months of June, July and August.

MATHEMATICS.

The subject of Mathematics is taught by a corps of instructors, each having charge of a small class. This arrangement secures a maximum of individual instruction for the student. Graded sections of the various mathematical branches are maintained to suit the needs of the men and each student resumes his study of Mathematics at the point where his previous training ended. All new students have an opportunity to review any part of the work and those who arrive at odd times during the year are accommodated by the system in vogue of organizing additional classes at specified intervals.

1136. PRACTICAL MATHEMATICS. *Lectures.*

Offered every semester, three hours a week.

Course VIII.

Text: Wells and Hart, *New High School Arithmetic.*

Sections II, III, Mr. Leonard, Mr. Miller, Mr. deCousser.

This course is designed for those whose mathematical training is scant as well as for those who have had more training, and embraces the most elementary parts of the subject. It is designed to prepare the student for the employment of logical reasoning in his mathematical computations and to give him the ground-work in mathematics. The course is divided into three sections in order to meet the individual requirements of the student.

Subjects: The fundamental operations, fractions, proportion, weights and measures, mensuration, measuring instruments, weight, pulleys, belts, horse-power, solution of an equation, logarithms, solution of a triangle, use of tables, slide rule, etc.

1137. PLANE GEOMETRY. *Lecture.*

Offered every semester, three hours a week.

Course VIII (1136).

Text: Stone and Millis, *Plane and Solid Geometry.*

Sections I, II. Mr. Layton, Mr. Guy.

This course is intended to supplement the student's elementary work in Mathematics, and to induce an appreciation of the fundamental propositions of practical geometry. Considerable emphasis is laid on construction problems and those theorems having a general application.

1138. PRACTICAL ALGEBRA. *Lectures.*

Offered every semester, three hours a week.
Course VIII (1136).
Text: Wells and Hart, *New High School Algebra.*
Sections I, II, III, IV. Mr. Pence, Mr. Jett, Mr. Worley, Mr. Guy.

This course aims to make the transition from arithmetic to algebra as easy and natural as possible, and at the same time to arouse and sustain the student's interest in the new field of work and eventually to make the student proficient in the fundamental algebraic processes and in their application to the numerous computations in the branches of engineering he may elect to pursue later in his course. The course will start from the elements of algebraic reasoning and carry the student through all the fundamental parts of the subject to quadratics.

1139. ADVANCED ALGEBRA. *Lectures.*

Offered every semester, three hours a week.
Course VIII (1138).
Text: Wells and Hart, *New High School Algebra.*
Sections I, II. Mr. Keeling, Mr. Fischlowitz.

This course is a continuation of course 1138 and deals with more advanced portions of the text and gives practical applications of the subject.

1140. PRACTICAL TRIGONOMETRY. *Lectures.*

Offered every semester, three hours a week.
Course VIII (1138).
Text: Taylor and Puryear, *Plane and Spherical Trigonometry.*
Mr. Fischlowitz.

The aim of this course is to give the student an intelligent and usable knowledge of the trigonometry underlying the technical and professional studies. The course is designed for vocational students who have not had the advantage of high school training mathematics. It differs from the regular collegiate course in the extent of time generally allotted to complete the course.

Subjects: Logarithms, use of tables, the right triangle, relation of functions, use of the slide rule, geometrical applications, latitudes and departures, simple triangulation, radian measure, applications to surveying, etc.

1141. ADVANCED TRIGONOMETRY. *Lectures.*

Offered every semester, three hours a week.
Course VIII (1140).
Text: Taylor and Puryear, *Plane and Spherical Trigonometry.*

Mr. Fischlowitz.

ENGLISH.

The aim of this course is to develop the power of effective communication of ideas in both speech and writing. It also aims to increase the power of observation and imagination, and adds to the student's store of knowledge and ideas.

1142. ELEMENTARY ENGLISH. *Lectures.*

Offered every semester, sixteen weeks, five hours a week.
Course VIII.
Text: Buhlig's, *Business English.*

Assistant Professor Bradley, Mr. Torrence.

The principles of English Grammar, including correct pronunciation, choice and use of words, correct spelling, clearness in the construction of sentences, use of capitals and punctuation marks, composition, letter writing, business forms, and the interpretation of English through the study of selected classics.

1143. ADVANCED ENGLISH. *Lectures.*

Offered every semester, sixteen weeks, five hours a week.
Course VIII (1142 or equivalent).
Texts: Buhlig's, *Business English.*
Selected Literature.

Assistant Professor Bradley.

Review of Grammar. A study of the sentence and the paragraphs. Composition work. Some of the underlying principles of rhetoric and their applications. Study of literary productions from some of the representative authors.

STUDENT ACTIVITIES

The American Association of Engineers, Missouri School of Mines Chapter.—The American Association of Engineers is a national organization, comprising all branches of the engineering profession. Its objects are to advance the standing of the profession and to promote the welfare and success of its members, particularly in non-technical matters.

The Missouri School of Mines Chapter was chartered in April, 1920, and has already come to be a recognized force in the school. All students are eligible to membership, and over half are members.

The chapter operated a Service Bureau at the opening of school, whereby, with the co-operation of the Rolla Chamber of Commerce, it was able to locate rooms for a great many of the new students. This service was entirely free and will be repeated each year.

The chapter stands for any movement which is for the good of the school, the city of Rolla, or both, its prime object being service—to members first, but also to the public at large. As it specializes on non-technical matters, it does not in any way conflict or compete with technical organizations. Its field, therefore, is practically unlimited.

The chapter officers for the year 1921-22 are:
M. W. Watkins.............................*President*
E. M. Guy.............................*1st Vice-President*
H. E. Zoller.............................*2nd Vice-President*

The Missouri Mining and Metallurgical Association.—The objects of the Mining and Metallurgical Association are to advance the knowledge of mining among its members, to promote good fellowship among the students and alumni of the School of Mines and others interested in mining, and to bring the School into closer relation with the mining profession at large. Students in the School of Mines who have passed in sixty-three credit hours are eligible to membership, as are also alumni.

This Association is affiliated with the American Institute of Mining and Metallurgical Engineers, and any member of it may become a junior member of the Institute. Such membership carries with it most of the privileges of regular membership at about one-half of the cost and with no initiation fee.

Officers of the association for the year 1921-22 are:

I. F. Hodges .... *President*
Prof. C. R. Forbes .... *Vice-President*
J. F. Hosterman .... *Secretary*
H. F. Valentine .... *Treasurer*

Metallurgical and Chemical Society.—The society meets fortnightly for the consideration and discussion of addresses, lectures, and informal talks on metallurgical and chemical topics—theoretical, practical, and industrial—delivered by students, faculty, and visiting professional men.

Students of metallurgy or chemistry with at least forty-three hours' credit are eligible as active members; other students having forty-three hours' credit or more may become associates.

Student Council.—The Student Council has for its object the promotion of various student enterprises and activities, and the maintenance of a spirit of mutual confidence between the student body and the faculty. The Council is composed of three Seniors and two Juniors, selected by the entire student body.

The members of the Council for 1921-22 are:

W. Kedzie Teller, *President.*
Warren Roy Gettler, *Secretary.*
A. B. Parkhurst,
E. S. Wheeler,
T. G. Weir.

Athletic Association.—The object of the Association is to unite the various efforts of the School in athletic sports. All students pay an athletic fee of five dollars a semester, which entitles them to membership in the Athletic Association, to admission to all athletic contests held under the auspices of the Athletic Association, and to golf club and gymnasium privileges. Members of the faculty may become members of the Association by the payment of the stipulated fee. The Association elects its own officers and has general charge of all school athletics. The financial affairs of the Association are handled by a Board of Control. (See under Physical training, page 127.)

The officers of the Association for 1921-22 are:

S. I. Zook .... *President*
E. J. Wendel .... *Vice-President*
Edw. Kahlbaum .... *Secretary-Treasurer*
D. F. Updike .... *Business Manager*

The Rollamo.—The *Rollamo*, first published in 1907 by the fraternities, is now edited by a staff chosen from the entire student body. The publication is the official yearbook of the school, and chronicles in permanent form the activities of the school year.

The Board for 1921-22 consists of the following:

F. K. M. Hunter	*Editor-in-Chief*
V. H. Webster	*Business Manager*
Edw. Kahlbaum	*Treasurer*
H. C. Fleck	*Assistant Business Manager*
D. S. Mosby	*Secretary*
E. A. Keeler	*Athletic Editor*
N. M. Rountree	*Associate Editor*
R. O. Erickson	*Associate Editor*
Christopher Southern	*Associate Editor*
J. P. Bryan	*Art Editor*
W. S. Frame	*Photographer*

The Missouri Miner.—*The Missouri Miner* is a weekly publication and was established in 1914-1915. It records the news of each week of interest to the student body and to the Alumni. It has been adopted as the official organ of the Alumni Association.

The staff for 1921-22 is as follows:

S. M. Burke	*Editor*
H. L. Leonard	*Associate Editor*
E. S. Wheeler	*Contributing Editor*
A. B. Wilkerson	*Sports Editor*
H. F. Valentine	*Vocate Editor*
M. L. Frey	*Assistant Editor*
C. E. Millikan	*Assistant Editor*
W. K. Teller	*General Manager*
W. R. Luckfield, Jr.	*Business Manager*
Herron Hollow	*Advertising Manager*
M. W. Watkins	*Associate Advertising Manager*
J. H. Reid	*Assistant Advertising Manager*
G. A. Zeller	*Circulation Manager*
C. F. Schaefer	*Assistant Circulation Manager*

Fraternities.—There are five Greek-letter college fraternities, each maintaining a chapter house: Gamma XI of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha, and Alpha Delta Zeta of Lambda Chi Alpha.

Scholarship Fraternities.—The engineering scholarship fraternity, Tau Beta Pi, established its Missouri Beta chapter in the school in 1908; and in 1916 the professional engineering fraternity Theta Tau, installed its Iota chapter. On January 29, 1920, the scholarship fraternity, Phi Kappa Phi, installed its Missouri School of Mines chapter. On December 20, 1920, the geological mining and metallurgical fraternity, Sigma Delta Epsilon, installed its Eta Chapter.

Clubs.—The following clubs, Grubstakers, Prospectors, Bonanza, and Independents, are organized for the benefit of the members. Some of these clubs maintain boarding and rooming houses.

The M. S. M. Players.—The M. S. M. Players were organized in the early fall of 1921, to promote dramatics in all possible ways, particularly by the presentation of plays from time to time. The players present four or five plays each year, most of them being benefit performances for some other student organizations.

Membership is on a competitive basis—an applicant being required to compete for a place on the casts of plays and to successfully portray parts in two plays, or to render certain services on the business staff. All students and faculty members, as well as any lady residents in Rolla, are eligible to compete for membership.

The Players have already presented several very successful plays, their work being unusually good for amateurs.

The Officers for the year 1921-22 are:

M. W. Watkins, '23 . . . . *President*
Mrs. Charlotte Singleton . . . . *Vice-President*
H. L. Leonard, '22 . . . . *Secretary*
H. H. Armsby . . . . *Advisory Director*
J. P. Gordon, '23 . . . . *Director*
P. E. Fischer, '23 . . . . *Business Manager*
J. F. Hosterman, '22 . . . . *Stage Manager*
R. H. Knight, '22 . . . . *Property Manager*

The Glee Club.—The M. S. M. Glee Club, organized in 1921, promotes an interest in vocal music and its membership is open to all male students of the school.

The Glee Club, during the course of the year, presents informal entertainments in connection with other organizations, presents complete programs for certain mass meeting occasions, and gives at least one Glee Club Concert during the winter. It supports an auxiliary double quartet, membership in which is competitive among the regular members of the Glee Club.

Officers for the year 1921-22 are as follows:

G. L. Knight . . . . *President*
D. L. Moodie . . . . *Student Vice-President*
C. V. Mann . . . . *Faculty Vice-President*
L. E. Shire . . . . *Secretary*
T. G. Wier . . . . *Librarian*
W. D. Turner . . . . *Director*

DEGREES

CONFERRED IN 1921.

Bachelor of Science in Mine Engineering.

Hyman Isadore Albert
Harold Leland Bailey
William Hampton Baxter
Karl William Booker
Carroll Preston Burford
Kuang Yu Chang
Lawrence Collins
Lewis Ely Davidson
August Francis Delaloye
John Ray Fiedler
Percy Grant Forman
Meyer Gollub
Abner Decker Hahn
Homer Archer Hollingshead
Russell Wayne Hunt
Harold Waller Hurd
Henry William Hurst
Robert Eugene Illidge
William Weaver Keeler
Homer Chalmers Kerr
George Alfred Kroenlein, B.S. '20
Napoleon Bonaparte Larsh
Heng Yung Ma
Edwin Lawrence Miller, Jr.
Charles Roderick Mize
Herbert William Mundt
Herman Jacob Mutz
Albert Booth Needham
William Ferdinand Netzeband
Howard Oliver Norville
Felipe Buenaventura Ore
Nathan Packman
William Clark Powell
William Reed Quillam
Theodore Clayton Sherwood
Edwin Allsop Slover, B. S. '20
William Lincoln Stewart, Jr.
Richard John Stroup
Robert Knox Stroup
James Mortimer Wilson
Joseph Martland Wilson

Bachelor of Science in Metallurgy.

Arthur Lee Cairns
Wayman Crow
Richard Love Johnson
John Gaines Miller
Robert Lee Mook
Joseph Herman Rohloff
Samuel Norman Shanfeld
Hsin Pu Shih
Robert Newton Stubbs, Jr.

Bachelor of Science in Civil Engineering.

Jules Philip Colbert
Anvil Clark Williams

Bachelor of Science in General Science.

George Barnett Bloom
Robert Bruce, Jr.
Frederick William Shaw, M. D.

Bachelor of Science in Electrical Engineering.

Vern Ivan Keeter
Lloyd Earl Lumpkin
Milton Wardwell Wallace

Bachelor of Science in Chemical Engineering.

Marion Smith Badollet
Victor Kopple Fischlowitz
William McKinley Kahlbaum
Albert Charles Laun
Charles James Millar
Samuel Leonard Nevedomsky
Barney Nudelman
Earnest Wayne Rembert
Huston Taylor

Master of Science in Mine Engineering

John Hyer Bowles, B. S. '08
Lewis Ely Davidson, B. S. '21
William Walbridge Weigel, B. S. '20

Master of Science in Chemical Engineering

Marion Smith Badollet, B. S. '21
Barney Nudelman, B. S. '21

Master of Science in General Science

Georgena Josephine Clark, B. S.
Samuel Horace Lloyd, A. B.
Frederick William Shaw, M. D., B. S. '21

Engineer of Mines.

John Hyer Bowles, B. S. '08
Raul Chavez, B. S. '18
James Joseph Dowd, B. S. '16
Harry Albert Kluge, B. S. '18
John Charles Miller, B. S. '16
Lawrence Joseph Zoller, B. S. '18
William Henry Kamp, B. S. '07

Metallurgical Engineer

Frederick Grotts, B. S. '16
Albert Leo Trent, B. S. '15

Civil Engineer

Edgar Carl Moritz Burkhart, B. S. '18

STUDENTS

September 1, 1920—September 1, 1921

GRADUATE STUDENTS

*Ambler, Harry Atwood, B. S. '17 ...... *St. Louis, Mo.*
Badollet, Marion Smith, B. S. '19 ...... *Vincennes, Ind.*
Bowles, John Hyer, B. S. '07 .... *Lake Springs, Mo.*
Clarke, Georgena Josephine, B. S. '18, University of Missouri .... *Rolla, Mo.*
Davidson, Lewis Ely, B. S. '19 .... *Savannah, Mo.*
Fischlowitz, Victor Kopple, B. S. '19 ... *St. Louis, Mo.*
*Kamp, William Henry, B. S. '17, E. M. '21 .... *Pittsburg, Kan.*
*Knight, Garold Louis, B. S., University of Missouri .... *Joplin, Mo.*
Lloyd, Samuel Horace, A. B. '18, DePauw University, M. S. '21 .... *Rolla, Mo.*
McCune, Roger Thomas, B. S. '20, Case School of Applied Science .... *Rolla, Mo.*
McNely, Earl Joesting, B. A. '13, B. S. '16, M. E. '20 (B. S. '13, Shurtleff College) .... *Wood River, Ill.*
Millar, Charles James, B. S. '20 .... *Webb City, Mo.*
Nudelman, Barney, B. S. '19 .... *St. Louis, Mo.*
Shaw, Frederick William, M. D. '06, B. S. '21, M. S. '21 .... *Rolla, Mo.*
Weigel, William Walbridge, B. S. '19, B. S. '20, M. S. '21 .... *Fredericktown, Mo.*

CLASS OF 1921

Mine Engineering

Bailey, Harold Leland .... *Virginia, Ill.*
Baxter, William Hampton .... *Washington, D. C.*
Booker, Karl William .... *Kansas City, Mo.*
Burford, Carroll Preston .... *Beaumont, Tex.*
Chang, Kuang Yu .... *Honan, China.*
Collins, Lawrence .... *Quincy, Ill.*
Cornwell, Benjamin Sedgely .... *St. Louis, Mo.*

*Student, U. S. Veterans' Bureau.

Crawford, Howard Stanley............ *Riveria, Cal.*
Delaloye, August Francis............ *Rolla, Mo.*
Dunlop, William Harry............... *Beardstown, Ill.*
Fiedler, John Ray................... *Shelbyville, Ind.*
Forman, Percy Grant................. *Rolla, Mo.*
Guy, Earl McKinley.................. *Davenport, Iowa*
Hahn, Abner Decker.................. *Muscatine, Iowa*
Hammer, Bernard Eli................. *Stanton, Mo.*
Hollingshead, Homer Archer.......... *St. Joseph, Mo.*
Hunt, Russell Wayne................. *Independence, Mo.*
Hurd, Harold Waller................. *Paris, Mo.*
Hurst, Henry William................ *Kansas City, Mo.*
Keeler, William Weaver.............. *Tulsa, Okla.*
Kerr, Homer Chalmers................ *Rolla, Mo.*
Larsh, Napoleon Bonaparte........... *Nebraska City, Neb.*
*Lepper, Lewis...................... *Marlboro, Mass.*
Ma, Ken Yung........................ *Honan, China.*
Manning, Roger Ignatius............. *Accokeek, Md.*
Miller, Edwin Lawrence, Jr.......... *Kansas City, Mo.*
Mize, Charles Roger................. *Independence, Mo.*
Mook, Robert Lee.................... *St. Louis, Mo.*
Needham, Albert Booth............... *Collinsville, Ill.*
Netzeband, William Ferdinand........ *St. Louis, Mo.*
Norville, Howard Oliver............. *Rolla, Mo.*
Powell, William Clarke.............. *Salem, Mo.*
Quilliam, William Reed.............. *Fowlerton, Tex.*
Salmon, Julius Clarence, Jr......... *Rayville, La.*
Stewart, William Lincoln............ *Pittsburgh, Pa.*
Stroup, Richard John................ *Quincy, Ill.*
Stroup, Robert Knox................. *Quincy, Ill.*
White, Fred Pope.................... *Fort Worth, Tex.*
Wilson, James Mortimer.............. *Hannibal, Mo.*
Wilson, Joseph Martland............. *Rock Rapids, Iowa.*

Metallurgy

Cairns, Arthur Lee.................. *Rolla, Mo.*
Crow, Wayman........................ *St. Louis, Mo.*
Huffman, Daniel Elijah.............. *St. Louis, Mo.*
Johnson, Richard Love............... *Henryetta, Okla.*
Miller, John Gaines................. *Marshall, Mo.*
Rohloff, Joseph Herman.............. *St. Joseph, Mo.*
Schumacher, Leon Burr............... *St. Louis, Mo.*
Shih, Hsin Pu....................... *Honan, China.*
Updike, Donald Foster............... *Plainfield, N. J.*

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*Student, U. S. Veterans' Bureau.

Civil Engineering

Bohn, Edwin Joseph . . . . *St. Louis, Mo.*
Colbert, Jules Philip . . . . *Maryville, Mo.*
Denison, William Ray . . . . *Rolla, Mo.*
Williams, Anvil Clarke . . . . *Sullivan, Mo.*

Electrical Engineering

Keeter, Verne Ivan . . . . *Maysville, Mo.*
Wallace, Milton Wardwell . . . . *East Orange, N. J.*

Chemical Engineering

Ehler, Otto . . . . *Washington, Mo.*
Laun, Albert Charles . . . . *St. James, Mo.*
Rembert, Ernest Wayne . . . . *Jefferson City, Mo.*
Taylor, Huston . . . . *Rolla, Mo.*

General Science

Bloom, George Barnett . . . . *Maysville, Mo.*

Mechanical Engineering.

Deckmeyer, Fred August . . . . *St. Louis, Mo.*
Lumpkin, Lloyd Earl . . . . *Jefferson City, Mo.*

CLASS OF 1922

Mine Engineering

Ackers, Albert Louis . . . . *Staunton, Ill.*
Berliner, Sydney George . . . . *New York, N. Y.*
Bolt, William Weeks . . . . *Springfield, Ill.*
Brandenburger, Oscar Louis . . . . *Belleville, Ill.*
Bulger, John Leo . . . . *Gouverneur, N. Y.*
Cameron, Campbell Robinson . . . . *McAlester, Okla.*
de Cardenas, Emilio . . . . *La Paz, Bolivia.*
Charles, Beryl E . . . . *Salina, Kan.*
Childress, Harold Lyle . . . . *Galena, Kan.*
Christner, Glen Joyce . . . . *Horton, Kan.*
de Cousser, Kurt Herman . . . . *Rolla, Mo.*
Denison, Alvis Frederick . . . . *Cushman, Ark.*
Diers, George Peter . . . . *East Orange, N. J.*
Diers, Henry Ernest . . . . *East Orange, N. J.*
*Edwards, James Carter . . . . *Jefferson City, Mo.*
Ewing, Harold Kline . . . . *Macon, Mo.*
Gollub, Meyer . . . . *St. Louis, Mo.*

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*Student, U S. Veterans' Bureau.

Hagood, Lindell . . . . *Marshall, Mo.*
Henderson, Frank Irving . . . . *St. Louis, Mo.*
Hodges, Isaac Franklin . . . . *Granby, Mo.*
Hodges, Joseph Tipton . . . . *Granby, Mo.*
Hoke, William Franklin . . . . *Lees Summit, Mo.*
Hollow, Francis Herron . . . . *Cuba, Mo.*
Hosterman, John Francis . . . . *Kansas City, Mo.*
Hughes, Harry Herbert, Jr . . . . *Santa Monica, Cal.*
Hunter, Francis Kinloch Middleton . . . *London, England.*
Jewell, James Edwin . . . . *Kansas City, Mo.*
Jones, James Ewart . . . . *Pasadena, Cal.*
Keeler, Edgar Allen . . . . *Tulsa, Okla.*
Kohlbry, Francis Paul . . . . *St. Louis, Mo.*
Leonard, Homer Lakirby . . . . *Rolla, Mo.*
Loesche, Harry Charles . . . . *St. Louis, Mo.*
McGirl, James Nathaniel . . . . *Odessa, Mo.*
Metzger, William Herman . . . . *St. Louis, Mo.*
Mosena, Charles Clifford . . . . *Falls City, Neb.*
*Owens, Irvin King . . . . *St. Louis, Mo.*
Packman, Nathan . . . . *St. Louis, Mo.*
Patterson, Harold Ford . . . . *Warrensburg, Mo.*
Reid, Sidney Kincaid . . . . *McAlester, Okla.*
Richards, Robert Earl . . . . *Hutchinson, Kan.*
Richert, George Leo . . . . *Denver, Colo.*
Rixleben, Bruno . . . . *Jonesboro, Ill.*
*Rucker, Ambrose Chockley . . . . *Keytesville, Mo.*
Sample, Truman George . . . . *Fredericktown, Mo.*
Signer, Merton Ira . . . . *Tonica, Ill.*
Smith, Charles Landon . . . . *Rolla, Mo.*
Tragitt, Edmund Roland . . . . *Rolla, Mo.*
Truebger, Frederick Francis . . . . *Petersburg, Ind.*
*Valentine, Herman Frederick . . . . *Marshall, Mo.*
Weir, Thomas Glover . . . . *Webster Groves, Mo.*
Windsor, Paul Donovan . . . . *Belleville, Ill.*
Wolverton, Thatcher Siprell . . . . *Green River, Utah.*
Wyman, Glen Sherman . . . . *Kansas City, Mo.*

Metallurgy

Alcorn, Irwin Wyland . . . . *Ranger, Tex.*
Coffey, Glen Verlan . . . . *Wabash, Ind.*
Devereux, Andrew . . . . *Pachuca Hgo., Mexico.*
Dorris, Milburn Leo . . . . *Collinsville, Ill.*
Gettler, Warren Roy . . . . *Hannibal, Mo.*
Gray, Fred Edwin . . . . *Hot Springs, N. Mex.*

*Student, U. S. Veterans' Bureau.

Karges, Paul Henry .... *Kansas City. Mo.*
Kimmel, Victor Edward .... *Rochester, N. Y.*
Wheeler, Ernest Sterling .... *Madrid, Iowa.*

Civil Engineering

Erickson, Roy Oscar .... *Madrid, Iowa.*
Hollow, Edward John .... *Cuba, Mo.*
Kaullen, Fred Adam .... *Jefferson City, Mo.*
Kenyon, Ronald John .... *Rolla, Mo.*
Kenyon, Russell George .... *Rolla, Mo.*
Machin, Edward Gilbert .... *Bluffton, Mo.*
Rountree, Newton Marshall .... *Springfield, Mo.*
Smith, Ralph Day .... *Hutchinson, Kan.*
Teis, Kenneth Robert .... *Parkville, Mo.*
Watts, Aubrey Byron .... *Fredericktown, Mo.*

Mechanical Engineering

*Hayes, Stanley Merton .... *Wellsville, Mo.*

Electrical Engineering

Case, Walker Earnest .... *Rolla, Mo.*
Halasey, Francis Richard .... *Maryville, Mo.*

Chemical Engineering

Frey, Muir Luken .... *Bunker Hill, Ill.*
Knight, Ralph Henry .... *St. Louis, Mo.*
Lenox, Jennie Lynn .... *Rolla, Mo.*

General Science

Torrence, Edward James, Jr .... *St. Louis, Mo.*
*Whitworth, Virgil Lee .... *Nevada, Mo.*

Unclassified

Dougherty, John Herman .... *Peoria, Ill.*

CLASS OF 1923

Mine Engineering

BeDell, Milo Nanson .... *St. Louis, Mo.*
Burch, Ivan C .... *Georgetown, Ill.*
Burke, Stephen Michael .... *St. Louis, Mo.*

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*Student, U. S. Veterans' Bureau.

*Burley, John Eldridge................*Wichita, Kan.*
Buser, Henry Clarence...............*Webster Groves, Mo.*
Canales, Francisco Alejandro..........*Ayacucho, Peru.*
Cathcart, Everett Hunter.............*Kansas City, Mo.*
Chomeau, Henri......................*Clayton, Mo.*
Coffman, Frank W....................*Cowgill, Mo.*
Dooley, Glen Angus..................*Joplin, Mo.*
Fischer, Paul Edgar..................*Webster Groves, Mo.*
Fishburn, Clare Downing.............*Carthage, Mo.*
Fleck, Howard.......................*El Paso, Tex.*
Foran, Leo Anson....................*Sorento, Ill.*
Gibson, Dod Graham..................*Webster Groves, Mo.*
Gordon, John Pemberton, Jr..........*Jefferson City, Mo.*
Grady, Robert F., Jr................*St. Louis, Mo.*
Haberthier, Joseph John..............*Wichita, Kan.*
Ham, Neal Manget....................*Montgomery, Ala.*
Healey, Michael Vincent..............*Macon, Mo.*
Hegwer, Paul Jent...................*Sarcoxie, Mo.*
Hendry, David John..................*St. Louis, Mo.*
Hooper, Gerald Elmo.................*Cherryvale, Kan.*
Hoover, B. F........................*Trenton, Mo.*
Hubbard, Henry Guernsey.............*Woods Hole, Mass.*
*Huckins, Julian Greenway............*Kirkwood, Mo.*
Jewell, Armin Brene.................*Tulsa, Okla.*
Kaley, Charles Bayard...............*Gouverneur, N. Y.*
Keyes, Irvin Wilson.................*Richmond, Mo.*
Lay, Willard Claxton................*St. Clair, Mo.*
Layton, Ben McColloch...............*Ferguson, Mo.*
McBrian, Ray........................*Shawnee, Okla.*
McBride, Hollis Eugene..............*Cape Girardeau, Mo.*
McClellan, Maurice Hunter...........*Eminence, Mo.*
Martyn, Philip Francis..............*Cuba, Mo.*
*Matlack, Fred Palmore...............*Overland Park, Mo.*
Meeks, Felix Zollicoffer............*Marshall, Mo.*
Millikan, Carl E....................*Buffalo, N. Y.*
Moore, Hamilton.....................*St. Louis, Mo.*
Murphy, James Kenneth...............*Vinita, Okla.*
Murphy, Raymond Edward..............*Galena, Ill.*
Nunnally, Hilliard Nolan.............*Texarkana, Tex.*
Orr, Raymond Fitzgerald.............*Webb City, Mo.*
Parkhurst, Arlis Beckham............*Tulsa, Okla.*
Pence, Harry Simanton...............*Falls City, Neb.*
Pesout, Edward......................*St. Louis, Mo.*
Robertson, Sayle....................*Grant City, Mo.*
Runge, Charles Adelbert.............*Kirkwood, Mo.*

*Student, U S. Veterans' Bureau.

Ruoff, Carl Matthews................*Hannibal, Mo.*
Sapper, Ferdinand Eugene............*Galveston, Tex.*
Schmidt, Karl August................*Springfield, Mo.*
Schwarz, Herbert Grumbach..........*Syracuse, N. Y.*
Shire, Leo Edwin...................*Mexico, Mo.*
Sotier, Alfred Leon..................*St. Louis, Mo.*
Storrs, Stuart Esselman..............*Hannibal, Mo.*
*Tedford, Donald Samuel.............*Diamond, Mo.*
Teller, William Kedzie..............*Riverside, Ill.*
Teter, William Earl.................*Bunker Hill, Ill.*
Thomy, Lawrence.....................*St. Louis, Mo.*
Wailes, Donald David................*Eaton, Colo.*
Walling, William Henry Seward.......*Dayton, Wyo.*
Wanenmacher, Joel Melching.........*Steubenville, Ohio.*
Watkins, Marion Whitfield............*Memphis, Tenn.*
Weigel, Melvin Powell...............*Fredericktown, Mo.*
Weimer, Walter Henry...............*Girard, Kan.*
Wendell, Everett John...............*Peoria, Ill.*
Wilkerson, Augustus Benton..........*Aurora, Mo.*
Wilson, Edgar Mark..................*Caney, Kan.*
Zeller, George August...............*St. Louis, Mo.*
Zevallos, Robert Cavero.............*Callao, Peru.*
Ziegler, William Clark...............*Providence, R. I.*
Zimmerman, Desiderius...............*St. Louis, Mo.*
*Zook, Samuel Irwin..................*Buffalo, Kan.*
Zoller, Henry Eugene................*Tulsa, Okla.*

Metallurgy

Gregg, James Lawrence..............*Independence, Mo.*
Grip, Carl John.....................*Newtonville, Mass.*
Harris, Jim Van.....................*Moberly, Mo.*
Helmerichs, John Frederick..........*St. Louis, Mo.*
Lapee, Roland Joseph................*Sullivan, Mo.*
Lindgren, Roy Alexander.............*Chicago, Ill.*
Linzer, Leo Morris...................*New York, N. Y.*
Martin, Guy Verdier..................*Rolla, Mo.*
Reeves, John Milton..................*Anderson, Ind.*
*Walsh, David Francis................*St. Louis, Mo.*
Webster, Vance Herschel.............*Anderson, Ind.*

General Science

Sanguinet, Edwin H..................*St. Louis, Mo.*

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*Student, U. S. Veterans' Bureau.

Civil Engineering

Brown, Paul Macfarlane.............. *Jefferson City, Mo.*
Casey, Walter Eric.................... *Ramsey, Ill.*
Croft, George Albert.................. *Winterset, Iowa.*
Dierking, George Thomas............. *St. Louis, Mo.*
*Evans, Owen Richard................. *Granger, Mo.*
Frame, Wayne Shannon............... *Salesville, Ohio.*
Jett, Daniel Boone.................... *St. Louis, Mo.*
Knight, Jesse Ray..................... *Gallatin, Mo.*
Kasel, Rudolph Gustav................ *Washington, Mo.*
Nawn, George Francis................. *Rolla, Mo.*
Porter, Edwin Kemp................... *Holden, Mo.*
Scott, Guy Robert..................... *Diamond, Mo.*
Stuart, Samuel Henry.................. *Rolla, Mo.*
Tevis, Charles Cyrus.................. *Holden, Mo.*
Werner, Walter August................ *St. Louis, Mo.*
Westgard, James Arne................. *Rolla, Mo.*

Mechanical Engineering

Andrews, John Lewis................... *Rolla, Mo.*
Bowman, Kingston Miller.............. *Keokuk, Iowa.*
*Fipps, Elba Lafayette................. *Salem, Mo.*
Hoffman, Ralph Andrew............... *Reno, Ohio.*
Johnson, Walter Virgil................ *Cuba, Mo.*
Joslin, Verne George.................. *Rolla, Mo.*
Meinecke, Egmont Samuel............ *Bay, Mo.*
Wallace, John Festus.................. *Clearmont, Mo.*
Wilmesherr, Charles Frank........... *Cuba, Mo.*

Chemical Engineering

Beagles, Harry Jay.................... *Nevada, Mo.*
Bryan, Jean Paul...................... *Independence, Mo.*
Chappuis, Alfred Starkloff............ *St. Louis, Mo.*
Garretson, Walter Paul............... *Carthage, Mo.*
Gatts, William Prescott............... *Hannibal, Mo.*
Keeling, William Miller............... *Falls City, Neb.*
Mennie, Billy Raymond................ *Hannibal, Mo.*
Mosby, Donald Speed.................. *Jefferson City, Mo.*

Electrical Engineering

Homer, St. Clair....................... *Caddo, Okla.*
Schott, Theodore Christ............... *Jefferson City, Mo.*
Wells, Harry........................... *St. James, Mo.*

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*Student, U. S. Veterans' Bureau.

Unclassified

Murray, James Ellis.................. *Holden, Mo.*

CLASS OF 1924

Mine Engineering

Algermissen, Sylvester Cornelius....... *Montgomery, Mo.*
Backer, William Henry............... *Webster Groves, Mo.*
*Blake, Philip Leroy.................. *Lynn, Mass.*
Blount, Ralph A..................... *Potosi, Mo.*
Bowers, Carlos Gehtet................ *Carrollton, Mo.*
Carter, Ross Ashford................. *Bronaugh, Mo.*
Davidson, Robertson Van Arsdale..... *Cherryvale, Kan.*
Davis, Carl Bailey................... *Rolla, Mo.*
Dunlap, Myron Norman.............. *Monett, Mo.*
Eble, Otto Hugh..................... *St. Louis, Mo.*
Ellis, Clarence Frederick............. *Dallas, Tex.*
Ellis, Valmer John................... *Macon, Mo.*
Hamilton, Ray Randolph............. *Rolla, Mo.*
Haywood, Elbridge Gerry............. *South Centralia, Ill.*
Heidtman, Homer Henry.............. *Wright City, Mo.*
Hunt, Arlo Lowell................... *Independence, Mo.*
Johns, Edward Herbert............... *Carthage, Mo.*
McClelland, Myron.................. *Centralia, Mo.*
Magalis, Cyrus West................. *Dallas, Tex.*
Marek, Charles Harry................ *Sioux City, Iowa.*
Mikell, Waring...................... *Augusta, Ga.*
Monahan, Foster Francis Murray...... *Sapulpa, Okla.*
Powell, William Alvis................ *Lees Summit, Mo.*
Roese, David Franklin................ *Syracuse, N. Y.*
Runge, Albert Erwin................. *Kirkwood, Mo.*
Samples, Bourke.................... *Boonville, Ind.*
Schaefer, Christian Frederick.......... *Edgewood, Pittsburg, Pa.*
Schramm, Herbert Oscar............. *Elmhurst, L. I.*
Smith, Carleton..................... *Richmond, Ind.*
*Stover, Curtis Edward............... *East St. Louis, Ill.*
Sublett, Ira......................... *Texarkana, Tex.*
*TenEyck, Warren Everett............ *St. James, Mo.*
Tirre, Milton Frank.................. *Marshfield, Mo.*
Walker, Arthur Wellesley............. *East Orange, N. J.*
Walker, John Rawlings............... *Roodhouse, Ill.*
Wasmund, James Marvin.............. *Vinita, Okla.*
Wilson, Ray Ottis.................... *Boonville, Ind.*
Wright, Wilford Stillman............. *Sedalia, Mo.*

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*Student, U. S. Veterans' Bureau.

Metallurgy

Gabler, George Charles................*Coffeyville, Kan.*
Howard, Leon Sidney..................*Rolla, Mo.*
Kessler, Harry Harvey................*St. Louis, Mo.*
*Kratz, Francis O....................*Iola, Kan.*
Levinson, Arthur Aaron...............*Chicago, Ill.*
Remmers, Walter Edward...............*St. Louis, Mo.*
Schapiro, Leo........................*Chicago, Ill.*

Civil Engineering

Atkinson, Marion Lee, Jr.............*Chadwick, Mo.*
Barnard, Herbert Elery...............*St. Louis, Mo.*
Blickensderfer, John.................*Lebanon, Mo.*
Campbell, Jack Percy.................*Doniphan, Mo.*
Drouot, Harold Roberts...............*Tulsa, Okla.*
Greensweight, Arnold Sylvester.......*Rolla, Mo.*
Kenning, Russell Haywood.............*Hannibal, Mo.*
Knight, William Elam Hale............*Joplin, Mo.*
Luster, Thomas Cleveland.............*Chickasha, Okla.*
Naylor, Archie Waugh.................*Rolla, Mo.*
*Sanderson, Lawrence Halley..........*Fulton, Mo.*

Mechanical Engineering

Ballinger, Ross Angelo...............*Gallatin, Mo.*
*Ferry, L. W.........................*Elsberry, Mo.*
Hopper, Herbert William..............*Bronson, Kan.*
Metcalf, Clyde Scherry...............*Greenfield, Ill.*
Moodie, Dwight Linford...............*St. Louis, Mo.*
Strong, Frank Noble..................*Marshfield, Mo.*

Electrical Engineering

Barnett, William Jackson.............*Bristow, Okla.*
Christopher, James...................*Warrensburg, Mo.*
Fitzmaurice, Timothy Beeler..........*St. Joseph, Mo.*
Jett, James Everett..................*Rolla, Mo.*
Thompson, Peter Fergus...............*Goodland, Kan.*
Thompson, Thomas M...................*Goodland, Kan.*
Underwood, Fred James................*Rolla, Mo.*

Chemical Engineering

Buck, Albert Edward..................*Central Falls, R. I.*
Castelli, Joseph.....................*Knobview, Mo.*
Courtney, Robert Munson..............*Hannibal, Mo.*

*Student, U. S. Veterans' Bureau.

Hedberg, Alvor........................*Chicago, Ill.*
Hunt, Joseph Owen..................*Hannibal, Mo.*
Keeling, William Orval...............*Rolla, Mo.*
Kemper, Claud......................*St. Louis, Mo.*
Loevy, Donald Boehm...............*St. Louis, Mo.*
Sitzler, Carl W. B...................*St. Louis, Mo.*

General Science

Baumgartner, Benjamin Kent.........*Rolla, Mo.*
Karr, Edward Paul..................*Belleville, Ill.*
Smail, Mary Augusta...............*Rolla, Mo.*

Unclassified

Adams, Mary Zella..................*Rolla, Mo.*
Appley, Mary Ruth..................*Rolla, Mo.*
Badollet, Dorothy Katherine..........*Oil City, Mo.*
Campbell, Mary Elizabeth............*Rolla, Mo.*
Corey, Rowena Grace...............*Rolla, Mo.*
Dent, Hazel Rena...................*Rolla, Mo.*
Evans, George Hartwell..............*Sedalia, Mo.*
Farris, Billy........................*Rolla, Mo.*
Fipps, Delilah Mary.................*Salem, Mo.*
Harris, Emily.......................*Rolla, Mo.*
John, Vertie Olive...................*St. James, Mo.*
Kilgore, Roxie......................*Rolla, Mo.*
Kitchen, Elizabeth Sarah.............*Rolla, Mo.*
McCaw, Margaret...................*Rolla, Mo.*
McRae, Margaret....................*Rolla, Mo.*
Nolte, Pauline Josephine..............*Rolla, Mo.*
Powell, Letita Sybil..................*Rolla, Mo.*
Schuman, Ruth Esther...............*Rolla, Mo.*
Underwood, Helen..................*Rolla, Mo.*
Wiese, Helen Mae...................*Rolla, Mo.*
Wyant, Madge M....................*Rolla, Mo.*

SPECIAL STUDENTS

*Alton, William Joseph................*Columbia, Mo.*
Anderson, Allen James...............*Cobalt, Canada.*
*Behnke, James Dillon................*Wyoming, Iowa.*
Blankenship, David Aldersan..........*Beckley, W. Va.*
*Bush, William Hewitt, Jr.............*St. Louis, Mo.*
*Chapin, Elmer Fenton................*East St. Louis, Ill.*
Carlton, Hal Hopper.................*St. Louis, Mo.*
Collet, Charles John.................*Columbus, Ohio.*

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*Student, U. S. Veterans' Bureau.

Ferer, Hyman . . . . *University City, Mo.*
Gholson, John D . . . . *Ranger, Tex.*
Graham, William Schley . . . . *Spring Creek, Mo.*
Hodges, Wilfred Horace . . . . *Bridgeport, W. Va.*
Horrom, Dalton David . . . . *Rolla, Mo.*
Howard, Max Raymond . . . . *Springfield, Mo.*
Kiskaddon, Charles Graham . . . . *Tulsa, Okla.*
*Lawrence, Hiram Pettibone . . . . *Norfolk, Conn.*
*Lindenburger, Harvey R . . . . *Rantoul, Kan.*
McCarthy, James . . . . *Hannibal, Mo.*
McClurken, Craig Russell . . . . *St. Louis, Mo.*
*Meier, Albert Gordon . . . . *St. Louis, Mo.*
*Neil, Charles Bland . . . . *Republic, Mo.*
Oliver, Minturn . . . . *Westfield, N. J.*
Ost, Paul William . . . . *St. Louis, Mo.*
*Post, Frank . . . . *Midvale, N. J.*
Reinoehl, Clyde Oscar . . . . *Rolla, Mo.*
Riddle, John . . . . *Marion, Kan.*
Sanders, Eugene Bernard . . . . *St. Louis, Mo.*
*Schneeberger, Fred Christ . . . . *Webster Groves, Mo.*
Scott, Arthur . . . . *Rolla, Mo.*
*Siegle, William . . . . *St. Louis, Mo.*
Squires, Glenn Robert . . . . *Carthage, Mo.*
Stebbins, Willard Robert . . . . *Rolla, Mo.*
Walls, Cecil Albert . . . . *McAlester, Okla.*
Whitney, Henry McLeod . . . . *Kansas City, Mo.*
Woolrych, Edmund Hugh . . . . *St. Louis, Mo.*
*Yampolsky, Frank . . . . *St. Louis, Mo.*
*Zogg, Martin Florian . . . . *Granby, Mo.*

*NON-COLLEGIATE VOCATIONAL STUDENTS

Alexander, Garr Scott . . . . *Hancock, Mo.*
Allen, Cecil Hall . . . . *St. Louis, Mo.*
Angel, Hohn Leslie . . . . *St. Louis, Mo.*
Argus, George Lewis . . . . *Rolla, Mo.*
Atkins, Eugene Marvin . . . . *Pikeville, Ky.*
Baker, E. E . . . . *Dixon, Mo.*
Baker, Guy . . . . *Fredericktown, Mo.*
Balch, George James . . . . *Jamaica Plain, Mass.*
Ball, Otto . . . . *Atchison, Kan.*
Beach, Seth Clifford . . . . *Emporia, Kan.*
Belew, Ross Rudell . . . . *Salem, Mo.*
Bent, Merton Everett . . . . *Campello, Mass.*
Bettag, John James . . . . *Highland, Ill.*
Bisch, Felix Grover . . . . *Bonne Terre, Mo.*

*Student, U. S. Veterans' Bureau.

Bothwell, Max	*St. Louis, Mo.*
Brannan, Jess Earl	*Eldorado Springs, Mo.*
Brant, Ramond Freeman	*Chillicothe, Mo.*
Braun, Milville Francis	*St. Louis, Mo.*
Brooks, Eugene Williams	*Alton, Ill.*
Broom, Frederick Lawrence	*Sylvia, Kan.*
Brown, Rolla Oliver	*Moberly, Mo.*
Brumley, Richard Howlett	*St. Louis, Mo.*
Burke, Edward Harry	*St. Louis, Mo.*
Campbell, Chester Wilber	*Sedalia, Mo.*
Carey, John William	*St. Louis, Mo.*
Cassil, Lawrence A	*Mountain Grove, Mo.*
Chattillion, Alfred Ernest	*Dupo, Ill.*
Clearman, James	*Liberal, Kan.*
Coakley, John Leonard	*Kansas City, Mo.*
Coffman, William Alphonzo	*Rocky Mountain, Mo.*
Cope, Oliver Carroll	*St. Louis, Mo.*
Corridon, M	*Kansas City, Mo,*
Crane, Philip	*St. Louis, Mo.*
Crews, Ersel Guy	*Nardin, Okla.*
Crippen, Dale Levi	*Hutchinson, Kan.*
Culpepper, John Henry	*Howards Ridge, Mo.*
Cummins, Harry Edgar	*Rolla, Mo.*
Curry, Homer	*Campbell, Mo.*
Davis, William Cameron	*Licking, Mo.*
Dodd, Frank William	*Mason City, Iowa.*
Dimitry, John Andrew	*Overland, Mo.*
Dutton, Clyde Edward	*Roubidoux, Mo.*
Dyer, Jerrold Birkhead	*St. Louis, Mo.*
Edmiston, Ruby Clenton	*Rolla, Mo.*
Elshire, Elmer	*DeGraff, Minn.*
Epperson, William Homer	*St. Louis, Mo.*
Evans, Otto Henry	*Rolla, Mo.*
Farmer, Samuel Dewitt	*Galena, Kan.*
Follette, Darwin Mauley	*St. Louis, Mo.*
Ford, Robert L	*Allenville, Mo.*
Freeman, Louis Andy	*Leadwood, Mo.*
Fullton, William Robert	*Springfield, Mo.*
Gale, Richard Thomas	*Rolla, Mo.*
Gegan, Edward Philip	*St. Louis, Mo.*
Gerdts, John Walter	*Lincoln, Mo.*
Grant, Vern John	*Herrin, Ill.*
Gundemeyer, Milford Anthony	*St. Louis, Mo.*
Hamilton, Dallas Edward	*St. Louis, Mo.*
Harmer, Stewart Peacock	*Bourbon, Mo.*
Harte, Barteley Sylvester, Jr	*St. Louis, Mo.*
Hazelwood, Ivan Floyd	*Alton, Ill.*

Healey, Edward Lawrence............ *Rolla, Mo.*
Hogan, Willis Wesley................ *Marshall, Mo.*
Hollar, Percy Alvin.................. *Topeka, Kan.*
Holliday, Tolbert.................... *Pollock, Mo.*
Hope, Anderson Monroe.............. *Doniphan, Mo.*
Hope, Charles Henry................. *Doniphan, Mo.*
Houston, Arthur Columbus........... *St. Louis, Mo.*
Hunter, Charles Edward.............. *Rolla, Mo.*
Irwin, Henry Monroe, Jr............. *Terra Haute, Ind.*
Jerrett, Amos Frank.................. *Norwood, Mo.*
Johnson, Wallen Bernard............. *Willard, Mo.*
Johnson, Granville William........... *Rolla, Mo.*
Jones, Harry Paul.................... *Perry, Iowa.*
Jones, William Jackson............... *Edwardsville, Ill.*
Kelley, Ross Everett................. *Ironton, Ohio.*
Kibler, Byron Lee.................... *Sarona, Wis.*
Kilgore, William Morris.............. *Fayette, Mo.*
Killpatrick, Joseph Harris, Jr......... *St. Louis, Mo.*
Kimble, Delar........................ *St. Louis, Mo.*
Korte, Frederick Rhinehart........... *Arkansas City, Kan.*
Kruse, Edward Conrad............... *St. Louis, Mo.*
Kunder, Raymond John............... *Macon, Mo.*
Lancaster, Charles Meritt............. *Omaha, Neb.*
Lang, Arthur Eugene................. *East St. Louis, Ill.*
Lawhon, Frank....................... *Doniphan, Mo.*
Larson, William Olaf................. *Linngrove, Iowa.*
Littig, Edward Frank................. *St. Louis, Mo.*
Logan, Fames Augustus.............. *Rolla, Mo.*
Lowd, Francis Elliott................ *Boston, Mass.*
Lucas, Homer Ray................... *Mammoth Springs, Mo.*
Lumbley, Joseph Roy................ *Galena, Kan.*
Lyons, Bernard Francis.............. *St. Louis, Mo.*
McDonnell, Joseph Michael........... *St. Louis, Mo.*
McDonnell, Martin................... *St. Louis, Mo.*
McGee, Clarence Samuel............. *Kansas City, Mo.*
McGirr, Oscar....................... *Dixon, Mo.*
McGuire, Paul Robert................ *Castleton, Kan.*
Mahan, James Francis................ *Charlestown, Mass.*
Maloney, Marton Thomas............. *St. Louis, Mo.*
Martin, Ira Sanford.................. *Newton, Kan.*
May, John Joseph.................... *Arlington Heights, Mass.*
May, Luther Walter.................. *Morley, Mo.*
Mefford, James Russell.............. *Crittenden, Mo.*
Meglitsch, Anthony.................. *St. Louis, Mo.*
Mercer, Ellis Wellington.............. *St. Louis, Mo.*
Meyer, August William............... *Rolla, Mo.*
Milford, Minor Thomas............... *St. Louis, Mo.*

Milsted, Harry Stephen.............. *Rolla, Mo.*
Mitchell, James Emmett.............. *Rolla, Mo.*
Morris, Alva Rex.................... *Willard, Mo.*
Mullen, Edward Martin.............. *Hutchinson, Kan.*
Nelson, Eugene Harvey.............. *St. Louis, Mo.*
Nelson, Roy Peter.................. *St. Louis, Mo.*
Neuwirth, Alois George............. *St. Louis, Mo.*
Neves, Walter Lee.................. *Kansas City, Kan.*
Newton, Noah....................... *Lamar, Colo.*
O'Brien, Thomas James.............. *St. Louis, Mo.*
O'Hara, Samuel Burl................ *Rosendale, Mo.*
Oster, John Peter.................. *Jefferson City, Mo.*
Overeen, Marcil Eugene............. *Ramsey, Ill.*
Pollozolo, Leo..................... *St. Louis, Mo.*
Parker, Robert Leo................. *Rolla, Mo.*
Patton, James Ralph................ *Columbus, Kan.*
Petri, Roy Robert.................. *St. Louis, Mo.*
Phillips, Joe Abb.................. *St. Louis, Mo.*
Phillips, Wendell D................ *Fredericktown, Mo.*
Pirtle, Oscar Paul................. *Chariton, Iowa.*
Powers, William.................... *St. Louis, Mo.*
Ralston, Orville Ray............... *Springdale, Ark.*
Richardson, Raymond Earl........... *Campbell, Mo.*
Rodgers, William Dorris............ *Licking, Mo.*
Rolfes, Bernard Edward............. *St. Louis, Mo.*
Rollhaus, Phillip, Jr.............. *St. Louis, Mo.*
Rosell, Darrell Ruben.............. *Norborne, Mo.*
Rowland, Albert John............... *Relfe, Mo.*
Rozier, Ralph Rice................. *St. Louis, Mo.*
Sanders, James Lewis............... *Doniphan, Mo.*
Schramm, Edward Bernard............ *St. Louis, Mo.*
Schremp, Eugene Joseph............. *St. Louis, Mo.*
Schultz, Jack Thurman.............. *Rolla, Mo.*
Scrafton, Wallace Todd............. *Rolla, Mo.*
Shepherd, Fred William............. *Wichita, Kan.*
Shirley, Ernest Albert............. *Kennett, Mo.*
Shuck, John W. H................... *Louisiana, Mo.*
Shupe, Walter...................... *Chariton, Iowa.*
Skaggs, Frank Eugene............... *St. Louis, Mo.*
Smith, Edward Leonard.............. *St. Louis, Mo.*
Smith, Elwood Temple............... *Kansas City, Mo.*
Snell, Earl........................ *East St. Louis, Ill.*
Southern, Christopher.............. *Kansas City, Mo.*
Sparwasser, Edward William......... *Glasco, Kan.*
Spitzenberg, Harry Ludwig.......... *St. Louis, Mo.*
Stanton, Henry Thomas.............. *St. Louis, Mo.*
Steinrauf, Dewey William........... *St. Louis, Mo.*

Stimson, Clifford B . . . . *Rolla, Mo.*
Stimson, Everett T . . . . *Rolla, Mo.*
Sullivan, Robert. . . . . *St. Louis, Mo.*
Taylor, James Edwin. . . . . *Mason City, Iowa.*
Ternes, Anthony Vincent . . . .*Garden Plain, Kan.*
Tower, Paul Aaron. . . . . *Marshfield, Mo.*
Turner, Cecil A. . . . . *Washington, Iowa.*
Vaughan, John Eckle. . . . . *Pineville, Mo.*
Venable, Norman. *Herrick, Ill.*
Vincent, Delmar Floyd . . . . *Cardwell, Mo.*
Vincent, George Martin . . . . *Morgantown, Ohio.*
Walters, George Earl. . . . . *Upper Alton, Ill.*
Weakley, Franklin Eugene. . . . . *Kansas City, Mo.*
White, Herbert Vernon. . . . . *Pittsburg, Kan.*
White, Ralph Patrick . . . . *Kirksville, Mo.*
Whitlock, Glen H . . . . *Concord, Ill.*
Wiemken, William. . . . . *St. Charles, Mo.*
Wilburn, Ernest William. . . . . *Kennett, Mo.*
Wilkerson, Herbert Lyndon . . . . *Bolivar, Mo.*
Williams, Charles. *Licking, Mo.*
Williams, Gordon. *Joplin, Mo.*
Williams, Walter Thomas. . . . . *Towanda, Kan.*
Wilson, Edward Ernest. . . . . *St. Louis, Mo.*
Wollford, Henry Daniel . . . . *Salem, Ark.*
Wynn, Clarence Marion. . . . . *Tulsa, Okla.*
Yeager, Robert Lee . . . . *Joplin, Mo.*
Young, Charles Earl . . . . *St. Louis, Mo.*
Zimmerman, Charles Andrew. . . . . *Jefferson City, Mo.*
Zink, Robert Earl. *Independence, Mo.*

FRESHMAN CLASS, 1921

Ainsworth, Harry Doyle. . . . . *Roodhouse, Ill.*
Anderson, Mason Callaway . . . . *Clinton, Mo.*
Arnold, Charles Link. . . . . *Clinton, Mo.*
Baker, Donald Robert. . . . . *Kansas City, Mo.*
Bauman, George. . . . . *Brooklyn, N. Y.*
Berry, Hugh Rogers. . . . . *East St. Louis, Ill.*
Bohn, Russell Orlando. . . . . *West Union, Ill.*
Bossert, Harry Franklin . . . . *Rolla, Mo.*
Brexvoort, William Emison . . . . *Vincennes, Ind.*
Brown, Charles Reed. . . . . *Rolla, Mo.*
Browning, Bertie Lee. . . . . *Montrose, Mo.*
Buechler, William Oliver. . . . . *Belleville, Ill.*
Burg, Walter Angelo . . . . *East St. Louis, Ill.*
Byrd, James Howard. . . . . *Deepwater, Mo.*

Campbell, Lymrick Lester............ *Kansas City, Mo.*
Couch, Jamison Eberlee.............. *Hannibal, Mo.*
Craig, Charles Dewey................ *Galt, Mo.*
Cunningham, Clement .... *Carthage, Mo.*
Doolittle, Irl Russell.............. *Broken Arrow, Okla.*
Ellison, Kenneth Alfred............. *Sapulpa, Okla.*
Faudi, Philip William............... *St. Louis, Mo.*
Fink, Frank Otto.................... *Rolla, Mo.*
Foster, James Nelson................ *Linn Creek, Mo.*
Fleming, John Wilson................ *Indiana, Pa.*
Freeman, John Herbert............... *Newburg, Mo.*
Gaines, George Duggins.............. *Slater, Mo.*
Godwin, William..................... *Pinckneyville, Ill.*
Gorman, Eugene James................ *Davenport, Iowa.*
Griffin, Donald Norval.............. *Joplin, Mo.*
Grosch, Lyndall..................... *St. Louis, Mo.*
Groschan, William Robert............ *Kirkwood, Mo.*
Hardwicke, William Burnham.......... *Stratford, Conn.*
Harris, Joseph Nathan............... *Neosho, Mo.*
Hasselmann, Karl Frederick.......... *Rock Rapids, Iowa.*
Hauck, William Fred................. *St. Louis, Mo.*
Heim, Carl Joseph................... *Huntingburg, Ind.*
Heitman, Albert Louis............... *Lincoln, Ill.*
Highfill, James B................... *Pawhuska, Okla.*
Hill, Howard Freanor................ *Vinita, Okla.*
Hopkins, Leslie Brooks.............. *Maplewood, Mo.*
Horrom, Orman John.................. *Rolla, Mo.*
Howard, Earl Samuel................. *Chamois, Mo.*
Imus, Benjamin Lincoln.............. *Savannah, Mo.*
Irving, Charles Curran.............. *Packwood, Iowa.*
Ivins, Weber Entriken............... *Sweetwater, Tenn.*
Jackson, Frank Otis................. *Duncan, Okla.*
Jones, Charles Thompson............. *East St. Louis, Ill.*
Keith, Frank Crow................... *Leadwood, Mo.*
Kentnor, Charles B., Jr............. *St. Louis, Mo.*
Knoebel, Irvin George............... *Belleville, Ill.*
Ledford, Mike Alfred................ *Tulsa, Okla.*
Letts, George Brown................. *Jefferson City, Mo.*
Levy, Milton........................ *St. Louis, Mo.*
Lowey, Norman Joseph .... *Brooklyn, N. Y.*
Luster, Dwight Kerr................. *East Orange, N. J.*
McDonald, Wayne..................... *Fort Worth, Tex.*
Martin, Charles Lytton.............. *Sullivan, Mo.*
Martin, Fred Charles................ *Morris, Ill.*
Maxwell, Fay Terrell................ *Vandalia, Mo.*
Meng, Paul Krugar................... *Greenfield, Mo.*
Merrill, John Warren................ *Carthage, Mo.*

Miller, Robert Karl . . . . *Vincennes, Ind.*
Miller, William Lyman . . . . *Redwood City, Cal.*
Murry, Albert B. . . . . *St. Clair, Ill.*
Newbill, Cecil Albert . . . . *Deepwater, Mo.*
Nolen, Jack . . . . *Hannibal, Mo.*
O'Brien, Edward Bohen . . . . *Little Rock, Ark.*
Parker, Ray Arnold . . . . *Muskogee, Okla.*
Pett, Gerald Henry . . . . *Schuyler, Neb.*
Reid, Joseph Hugh . . . . *McAlester, Okla.*
Rood, John Atwood . . . . *Kansas City, Mo.*
Rueh, Clarence William . . . . *Rolla, Mo.*
Sanderson, Lawrence Haley . . . . *Fulton, Mo.*
Scott, Herbert Chester . . . . *Leadwood, Mo.*
Shire, Leo Edwin . . . . *Mexico, Mo.*
Smail, Mary Augusta . . . . *Rolla, Mo.*
Smith, Paul Avery . . . . *Collinsville, Okla.*
Springer, Lewis Reese . . . . *El Paso, Tex.*
Stogsdill, James Everette . . . . *Vida, Mo.*
Tarleton, Claude G., Jr. . . . . *Hannibal, Mo.*
Terry, Paul Albert . . . . *Galt, Mo.*
Thomas, John D. . . . . *Oblong, Ill.*
Underwood, Dale Fisher . . . . *Georgetown, Ill.*
Valerius, Claude Nathan . . . . *Stuart, Iowa.*
Ward, Ronald Davies . . . . *Webster Groves, Mo.*
Weirich, Frederick Adam . . . . *Spring Bluff, Mo.*
Weitzman, Jack . . . . *St. Louis, Mo.*
Whitesell, Paul Edgar . . . . *Martinsville, Ind.*
Whittlesey, Charles Chauncey . . . . *Castlewood, Mo.*
Wilson, Otho Melvin . . . . *Rolla, Mo.*

Special Students

(Year beginning September 1, 1921.)

Aldous, William N. . . . . *Litchfield, Ill.*
*Bishop, George Elia . . . . *Wichita, Kan.*
Bradley, Mrs. S. P. . . . . *Rolla, Mo.*
Dickey, Harris Brown . . . . *Montgomery City, Mo.*
Higdon, Clyde . . . . *Fredericktown, Mo.*
Hollems, Merle Cornelius . . . . *Rolla, Mo.*
Hynes, Julius Henry . . . . *St. Louis, Mo.*
Lyons, Joe Jerry . . . . *Springfield, Mo.*
O'Leary, John Mitchell . . . . *Cherryvale, Kan.*
Sutton, Carlos Ailsen . . . . *Fairland, Okla.*
Wanamaker, Mrs. Ruth Kimball . . . . . . *Rolla, Mo.*
Waranka, John Paul . . . . *Lutie, Okla.*
Williams, William Don . . . . *Vinita, Okla.*

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*Student, U. S. Veterans' Bureau.

Unclassified Students

(Year beginning September 1, 1921.)

Bullard, Naomi Jane................*Rolla, Mo.*
Davidson, Grace Rita................*Rolla, Mo.*
Delaloye, Marguerite Blanche.........*Rolla, Mo.*
Dent, Harry Lee.....................*Rolla, Mo.*
Durant, Winston John................*Rolla, Mo.*
Fairchild, Harrison Vaughn...........*Leadville, Colo.*
Hopkins, Elizabeth..................*St. Louis, Mo.*
Ingerson, Morris James...............*Bemus Point, N. Y.*
Johnson, Obbo William...............*St. Louis, Mo.*
List, Elmer.........................*Rolla, Mo.*
Lorts, Gladys Haley.................*Rolla, Mo.*
Mulford, Frank Cleo.................*Kansas City, Mo.*
Napper, Elmer Eugene................*Springfield, Mo.*

Vocational Students

(Year beginning September 1, 1921.)

Alexander, Garr Scott...............*Hancock, Mo.*
Amsberg, Charles August.............*Rolla, Mo.*
Angel, John Leslie..................*St. Louis, Mo.*
Baker, Everett Eugene...............*Rolla, Mo.*
Baker, Guy..........................*Fredericktown, Mo.*
Bollin, Charles J...................*St. Louis, Mo.*
Becker, Morris......................*St. Louis, Mo.*
Berry, George Franklin..............*Temple, Fla.*
Biggs, Walter.......................*Salem, Mo.*
Bratcher, Bernie....................*Campbell, Mo.*
Brooks, Willis Floyd................*Hornersville, Mo.*
Bullington, Felix Arthur............*Hayti, Mo.*
Danklef, Herman Dietrich............*Mt. Olive, Ill.*
Elliott, Lee E......................*Nevada, Mo.*
Federhofer, Aloysius................*St. Clair, Mo.*
Jones, Milton Harden................*Stella, Mo.*
Hawkins, Lonnie.....................*Rolla, Mo.*
Jackson, Edward William.............*Deepwater, Mo.*
Jenike, John Christian..............*Hume, Mo.*
Jesse, Joe Edward...................*St. Louis, Mo.*
Johnson, Reginald Augustine..........*Pleasant Hill, Mo.*
Kasch, Walter.......................*Webster Groves, Mo.*
Keckler, Clarence Edward............*Muscatine, Iowa.*
Kennedy, Daniel.....................*St. Louis, Mo.*
Laney, Urig V.......................*Billings, Mo.*
Morrison, William Alaf..............*Linn Grove, Iowa.*
Launius, Chester Clyde..............*Bloomfield, Mo.*

Letterman, John Francis . . . . *St. Louis, Mo.*
McCormick, Duncan . . . . *Troy, Ill.*
McKeown, Frank Robert . . . . *St. Louis, Mo.*
Miller, George Handley . . . . *Overland, Mo.*
Nantista, Frank Paul . . . . *New York, N. Y.*
Nolen, Ray Samuel . . . . *Advance, Mo.*
Pasley, James Lingan . . . . *Mexico, Mo.*
Smith, Edward Albert . . . . *Belle, Mo.*
Steinmeyer, William Frederick . . . . *St. Louis, Mo.*
Strain, Earl P . . . . *Rolla, Mo.*
Thomas, James Newton . . . . *St. Louis, Mo.*
Thompson, John Claude . . . . *Seneca, Mo.*
Thompson, Kenneth Keith . . . . *Galena, Kan.*
Townsend, Cyril D . . . . *Mathews, Mo.*
Underwood, James . . . . *Dunnegan, Mo.*
Williams, Frank Everett . . . . *Charleston, Mo.*
Williams, Frank Leonard . . . . *Paola, Kan.*
York, Walter Delbert . . . . *Flat, Mo.*

SUMMARY

Students September 1, 1920—September 1, 1921

Graduate Students	15
Seniors	62
Juniors	81
Sophomores	123
Freshmen	81
Unclassified	21
Specials	37
Vocational	184
Total	604

Students Enrolled Between September, 1921, and January 1, 1922

Freshmen	90
Specials	13
Unclassified	13
Vocational	45
Total	161

BULLETINS OF THE MISSOURI SCHOOL OF MINES

GENERAL SERIES

Vol. 1, No. 1, Dec., 1908. The Human Side of a Mining Engineer's Life. Edmund B. Kirby. (Commencement address, June 10, 1909.)

Vol. 1, No. 2, 38th Annual Catalogue, 1909-1910.

Vol. 1. No. 3, June, 1909. Education for Utility and Culture. Calvin M. Woodward. (Tau Beta Pi address.)

Vol. 1, No. 4, Sept., 1909. The History and Development of the Cyanide Process. Horace Tharp Mann.

Vol. 2, No. 1, Dec., 1909. The Jackling Field, School of Mines and Metallurgy.

Vol. 2, No. 2, 39th Annual Catalogue, 1910-1911. (*Out of print.*)

Vol. 2, No. 3, June, 1910. Some of the Essentials of Success. Charles Summer Howe. (Commencement address, June 1, 1910.)

Vol. 2, No. 4, Sept., 1910. Friction in Small Air Pipes. E. G. Harris, Albert Park, H. K. Peterson. (Continued by Technical Series. Vol. 1, Nos. 1 and 4.)

Vol. 3, No. 1, Dec., 1910. Some Relations Between the Composition of a Mineral and Its Physical Properties. G. H. Cox, E. P. Murray.

Vol. 3, No. 2, March 1, 1911. 40th Annual Catalogue, 1911-1912.

Vol. 3, No. 3, June, 1911. Providing for Future Generations. E. R. Buckley. (Tau Beta Pi address, May 24, 1911.)

Vol. 3, No. 4, Sept., 1911. Fall Announcement of Courses. (*Out of print.*)

Vol. 4, No. 1, Dec., 1911. Fortieth anniversary of the School of Mines and Metallurgy of the University of Missouri. Parker Hall Memorial Address. Laying of cornerstone of Parker Hall, Rolla, Missouri, October 24, 1911. (*Out of print.*)

Vol. 4, No. 2, March, 1912. 41st Annual Catalogue, 1912-1913. (*Out of print.*)

Vol. 4, No. 3, June, 1912. Mining and Civilization. J. R. Finlay. (Commencement address, May 31, 1912.)

Vol. 4, No. 4, Sept., 1912. Fall announcement of courses. (*Out of print.*)

Vol. 5, No. 1, Dec., 1912. Student Life.

Vol. 5, No. 2, March, 1913. 42nd Annual Catalogue, 1912-1913.

Vol. 5, No. 3. Never published.

Vol. 5, No. 4. Never published.

Vol. 6, No. 1. Never published.

Vol. 6, No. 2, March, 1914. 43rd Annual Catalogue, 1913-1914.

Vol. 6, No. 3. Never published.

Vol. 6, No. 4. Never published.

Vol. 7, No. 1. Never published.

Vol. 7, No. 2, March, 1915. 44th Annual Catalogue, 1914-1915.

Vol. 7, No. 3, June, 1915. Description of special courses in oil and gas and allied subjects.

Vol. 7, No. 4, Sept., 1915. Register of Graduates, 1874-1915.

Vol. 8, No. 1, Jan., 1916. Bibliography on Concentrating Ores by Flotation. Jesse Cunningham.

Vol. 8, No. 2, March, 1916. 45th Annual Catalogue, 1915-1916. (*Out of print.*)

Vol. 8, No. 3, June, 1916. The Business of Mining. W. R. Ingalls. (Commencement address, May 26, 1916.)

Vol. 8, No. 4, Oct., 1916. Register of Graduates, 1874-1916. (*Out of print.*)

Vol. 9, No. 1, Jan., 1917. Road Problems in the Ozarks. E. G. Harris. Bibliography on Rural Roads. H. L. Wheeler.

Vol. 9, No. 2, March, 1917. 46th Annual Catalogue, 1916-1917.

Vol. 9, No. 3, June, 1917. What Should a Present-Day Metallurgical Education Comprise? Charles Hermann Fulton. (Commencement address, May 25, 1917.)

Vol. 9, No. 4, Oct., 1917. Register of Graduates, 1874-1917. M. S. M. men in military service.

Vol. 10, No. 1, Jan., 1918. Student Life; Revised Edition.

Vol. 10, No. 2, March, 1918. 47th Annual Catalogue, 1917-1918.

Vol. 10, No. 3, June, 1918. The Human Side of Mining Engineering. James Furman Kemp. (Commencement address, May 24, 1918.)

Vol. 10, No. 4, Oct., 1918. (Delayed.) List of publications wanted by the library, and of duplicates available for sale or exchange, April, 1920.

Vol. 11, No. 1, Jan., 1919. (*In preparation.*)

Vol. 11, No. 2, March, 1919. 48th Annual Catalogue, 1918-1919.

Vol. 11, No. 3, June, 1919. Road Problems in the Ozarks; 2nd edition, revised and extended. G. E. Harris. Bibliography on rural roads. H. L. Wheeler.

Vol. 11, No. 4, October, 1919. Register of Graduates, 1874-1919.

Vol. 12, No. 1, Jan., 1920. War Service Records of the Missouri School of Mines. Compiled by G. E. Ebmeyer.

Vol. 12, No. 2, March, 1920. 49th Annual Catalogue, 1919-1920.

Vol. 12, No. 3, June, 1920. Contemporary Novels and Novelists; A List of References. H. L. Wheeler.

Vol. 12, No. 4, October, 1920. Department of Vocational Education.

Vol. 13, No. 1, Jan., 1921. Register of Graduates, 1874-1921.

Vol. 13, No. 2, March, 1921. 50th Annual Catalogue, 1920-1921.

Vol. 14, No. 3, June, 1921. Training for Exploration. H. Foster Bain. (Commencement address, April 29, 1921.)

Vol. 14, No. 4, Oct., 1921. Department of Vocational Education.

Vol. 15, No. 1, Jan., 1922. A Symposium of Mining and Metallurgical Education. (*In press.*)

Vol. 15, No. 2, March, 1922. 51st Annual Catalogue, 1921-1922.

TECHNICAL SERIES

Vol. 1, No. 1, Nov., 1911. Friction in Air Pipes. E. G. Harris. (Continuation of General Series, Vol. 2, No. 4.)

Vol. 1, No. 2, Feb., 1912. Metallurgy and Ore Dressing Laboratories of the Missouri School of Mines and Metallurgy. D. Copeland, H. T. Mann, H. A. Roesler. (*Out of print.*)

Vol. 1, No. 3, May, 1912. Some Apparatus and Methods for Demonstrating Rock Drilling and the Loading of Drill Holes in Tunnelling. L. E. Young.

Vol. 1, No. 4, Aug., 1912. Friction in Air Pipes. E. G. Harris. (Continuation of Vol. 1, No. 1, Nov., 1911.)

Vol. 2, No. 1, Aug., 1915. Comparative Tests of Piston Drill Bits. C. R. Forbes and L. M. Cummings.

Vol. 2, No. 2, Nov., 1915. Orifice Measurements of Air in Large Quantities. Elmo G. Harris.

Vol. 2, No. 3, Feb., 1916. Cupellation Losses in Assaying. Horace T. Mann and Charles Y. Clayton.

Vol. 2, No. 4, May, 1916. Geologic criteria for determining the structural position of sedimentary beds. G. H. Cox and C. L. Dake. (*Out of print.*)

Vol. 3, No. 1, Aug., 1916. Experiments from the Flotation Laboratory. C. Y. Clayton. (*Out of print.*)

Vol. 3, No. 2, Nov., 1916. Studies on the Origin of Missouri Cherts and Zinc Ores. G. H. Cox, R. S. Dean and V. H. Gottschalk.

Vol. 3, No. 3, Feb., 1917. Preliminary Report on Blended Portland Cement. E. S. McCandliss.

Vol. 3, No. 4, May, 1917. Studies in the Production of Oils and Tars from Bituminous Materials. J. C. Ingram.

Vol. 4, No. 1, Aug., 1917. The Hydrometallurgy and Electrolytic Precipitation of Zinc. F. D. James.

Vol. 4, No. 2, Nov., 1917. The Effect of Addition Agents in Flotation. Part I. M. H. Thornberry and H. T. Mann.

Vol. 4, No. 3, Feb., 1918. Bibliography: Roasting, Leaching, Smelting, Electric Smelting and Electrolysis of Zinc. H. L. Wheeler.

Vol. 4, No. 4, May, 1918. An Investigation of Blended Portland Cement. E. S. McCandliss and H. H. Armsby.

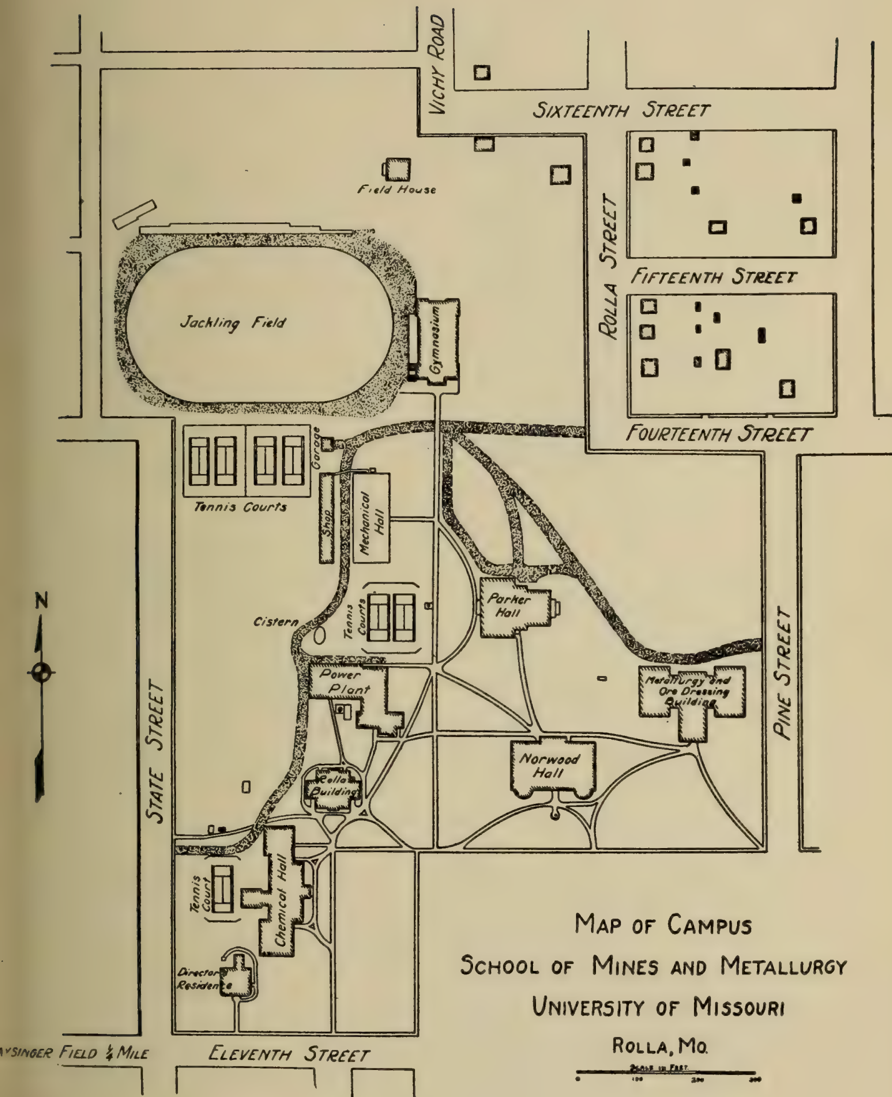
Vol. 5, No. 1, Aug., 1919. The Carbonization of Missouri Cannel Coals. H. L. Dunlap, K. K. Kershner and V. X. Smiley.

Vol. 5, No. 2, Nov., 1919. The Effect of Addition Agents in Flotation. Part II. M. H. Thornberry and H. T. Mann.

Vol. 5, No. 3, Feb., 1921. An Investigation of the Xylenes Obtained from the Carbonization of Coal. W. D. Turner. (*In press.*)

Vol. 5, No. 4, May, 1921. Coal Mining Methods in Missouri. W. W. Weigel.

Vol. 6, No. 1, Aug., 1921. The Problem of the St. Peter Sandstone. C. L. Dake.



MAP OF CAMPUS
SCHOOL OF MINES AND METALLURGY
UNIVERSITY OF MISSOURI
ROLLA, MO.

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